Applied Mechanics Reviews

A Critical Review of the World Literature in Applied Mechanics

L. H. DONNELL, *Editor*

T. VON KÁRMÁN, S. TIMOSHENKO, *Editorial Advisers*

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Abbreviations of units follow the standard of Abbreviations for Scientific and Engineering Terms of the Am. Standards Assoc. Examples: psi (pounds per square inch); cps (cycles per second); mph (miles per hour).

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General Kinematics, Statics, Dynamics

(See Revs. 29, 70, 110)

Gyroscopics, Governors, Servos

1. A. M. Letov, "On the theory of the isodrome governor" (in Russian), *Appl. Math. Mech. (Prikl. Mat. Mekh.)*, July-Aug. 1948, vol. 12, pp. 363–368.

Boolgakov's work on automatic governors with a servomotor actuated by a nonlinear error function involving the error, as well as the first and second derivatives of the error, is closely followed in the present application to isodrome governors subjected to an unvarying external disturbance. The present case differs from Boolgakov's in that the second derivative of the error is replaced by an integral of the error. The nonlinear error function is linearized and the conditions for the existence of a periodic solution are formulated. The Routh discriminant and Boolgakov's semigraphical method are used in determining stable, unstable and neutrally stable regions. Walter W. Soroka, USA

2. Norbert Wiener, "Cybernetics," John Wiley & Sons, New York, 1948. Cloth, 9.3 × 6 in., 194 pp., $3.

The emphasis on personalities and the advance publicity should not mislead the scanner of this book into underestimating its scientific message. The title is derived from a Greek work of which "governor" is a corruption. The scientific sections point out a multitude of phenomena in the nervous system analogous to those encountered in automatic regulation and statistical handling of communication. Of special interest is the duplication of pathological phenomena (purpose tremor) in servomechanisms.

The book has little unity; the author unburdens himself jauntily of a host of ideas, some of which are related only by belonging to the same mind. The long introduction is autobiographical gossip and haggling about the author's contribution to the war effort. The factual parts in it are dependent on things appearing 150 pages later. Chapter I (Newtonian and Bergsonian time) is a brilliant discussion of the correlations between scientific and technological thought—really, a chapter on sociology of science, having little to do with the title subject. Chapters II and III present abstract mathematical developments with a conciseness eliminating the nonprofessional mathematician. They deal with the foundation of group theory, statistical mechanics (ergodic theory), and statistical theory of communication. Chapter IV (Feed-Back and Oscillation) presents the elements of automatic regulation. Chapter VIII (Information, Language and Society) is frankly informal sociology with accents on social justice.

The servomechanism engineer as well as psychologists, biologists and others will be interested in hypothetical block diagrams of nervous mechanisms (Chapter IV) and analogies between the human nervous system and computing machinery (Chapter V). Chapter VII (Gestalt and Universals) deals with the mechanism of visual shape recognition, with application to the possibility of replacing vision by hearing. Chapter VII attempts to suggest analogies between mental disorders (in which memory is assumed to play a vital part) and malfunctioning of computing machinery, and even extends this analogy to therapy. Problems of overload are compared with those in a telephone exchange. Handedness and brain efficiency are discussed in terms of neuron-chain connections.

Many factual remarks are scattered among pages which are not of factual interest as a whole. Most of the unexplained medical terminology can be found in unabridged dictionaries. The author's readable digest of these problems can be found in *Scientific American*, November 1948, p. 14.

A. W. Wundheiler, USA

3. M. Almeras, "Characteristics of the control systems (Charactéristiques des régulateurs)," *Houille blanche*, Nov.-Dec. 1947, vol. 2, pp. 457–467.

The author compares an acceleration-velocity governor with a dashpot one, and shows how the characteristic dimensions of both types are to be chosen in order to obtain good stability conditions in modern turbine plants. These require an always increasing regulation speed, owing to the fact that hydraulic inertia tends to increase while the mechanical one tends to decrease.

Carlo Ferrari, Italy

4. M. Avramy Melvin, "Theory of automatic control systems," *J. appl. Phys.*, Aug. 1947, vol. 18, pp. 704–722.

This report discusses the theory of servomechanisms from a conventional point of view. Curves are presented which have been calculated to simplify the selection of parameters in the design of systems. The discussion is quite general. The author has used a nomenclature and a set of symbols of his own selection, which make the text quite difficult to follow.

R. G. Wilson, USA

Vibrations, Balancing

(See also Revs. 1, 7, 73, 112, 114, 116, 129, 133, 134)

5. Frank Massa, "A new method of vibration measurement for the frequency range 20 to 20,000 cps," *Instruments*, Nov. 1948, vol. 21, pp. 1012–1014.

This paper describes a piezoelectric-type acceleration detector in which the sensitive element is an assembly of several ammonium dihydrogen phosphate (ADP) crystals. Output is directly proportional to acceleration from 10 to 10,000 cps. Sensitivity is of the order of 0.1 volts per g measured across the low-impedance output terminals of the preamplifier.

Charles E. Crede, USA

Wave Motion, Impact

(See also Revs. 75, 76, 90, 101, 110, 132, 135, 136, 137)

6. F. Ursell, "On the waves due to the rolling of a ship," *Quart. J. Mech. appl. Math.*, June 1948, vol. 1, pp. 246–252.

This paper investigates the linearized two-dimensional problem

of a thin rigid plate which is partially immersed in a fluid, and which oscillates about a horizontal axis. Such an arrangement is considered to be a model for the rolling motion of a ship. It is found that surface waves arise which are essential for the damping of the motion. First a hypothesis is made which satisfies the differential equation of the flow and the boundary conditions at the free surface. The conditions given in the vertical plane through the axis of the plate lead to a pair of integral equations which are solved explicitly. The theory checks well with experimental results. Gottfried Guderley, USA

7. Elbridge Z. Stowell, Edward B. Schwartz, and John C. Houbolt, "Bending and shear stresses developed by the instantaneous arrest of the root of a moving cantilever beam," *Nat. adv. Comm. Aero. Rep.*, no. 828, 1945 (issued in 1948), pp. 1–9.

The authors derive formulas for deflections, accelerations, and bending and shear stresses for each mode of a vibrating cantilever beam whose root is subjected to a step-function type of velocity variation. Strain-gage measurements on 1-in-diam 0.028-in-thickness tubes of various lengths on a pendulum mount show good agreement with theoretical predictions of frequency and bending and shear stresses for the lowest mode. For any given mode and station, bending stress is independent of beam length, while shear stress varies inversely with beam length.

G. A. Nothmann, USA

8. E. Gerjuoy, "Refraction of waves from a point source into a medium of higher velocity," *Phys. Rev.*, June 15, 1948, vol. 73, pp. 1442–1443.

Two mediums are separated by an infinite plane boundary. A point source of sound is placed in one medium and the sound field in the second is calculated. It is assumed that the wave velocity in the second medium is greater than that in the first. Absorption is neglected and the problem is solved in two ways. The author applies the ray method and then uses an exact solution of the wave equation which is made useful by an application of the method of steepest descent.

Courtesy of Mathematical Reviews A. E. Heins, USA

9. M. P. Regnauld, "Centric impact in elastic bodies (Choc centrique de corps élastiques)," *Mémor. Artill. fr.*, 1948, vol. 22, no. 1, pp. 7–98.

This work is divided into two sections. The first part deals with the calculation of the change in velocities in problems involving the impact of two bodies and of three bodies. The main feature of the treatment is the use of a parameter which is a measure of the decrease in the kinetic energy of the system, rather than the Newtonian coefficient of restitution.

The second part gives an analysis of impact phenomena, assuming that the time variation of the impact force can be approximated by a step-function whose duration is equal to the time of impact. The paper is mainly theoretical.

R. M. Davies, Wales

10. Walter Ramberg and Albert E. McPherson, "Experimental verification of theory of landing impact," *J. Res. Nat. Bur. Stands.*, Nov. 1948, vol. 41, pp. 509–520.

In an unpublished paper presented at the 1946 International Congress of Applied Mechanics, Biot and Bisplinghoff proposed a method of computing the maximum bending and torsional moments in an airplane wing structure subjected to loadings through the landing gear.

This paper describes model tests made for the purpose of corroborating the method of calculation, and discusses the assumptions involved in the calculations. Drop tests on an idealized wing and landing gear included measurements of bending strains, landing forces and fuselage accelerations. Fore-and-aft symmetry was maintained in the model so as to avoid torsional moments.

The computed maximum bending moments, according to the method of Biot and Bisplinghoff, were found to differ from the tests by −15 to +51 per cent. For the maximum acceleration of the fuselage, the difference was +8 to +43 per cent. It is pointed out that the computed accelerations of outboard sections of the wing would be subject to large errors due to neglect of phase differences in the analysis.

Drop tests on a wing model torsionally similar to an actual wing are described in a paper by Leal, Bisplinghoff, and Pian [*Proc. Soc. exp. Stress Anal.*, 1948, vol. 6, no. 1, p. 115]. The drop-test measurements of bending moments agreed fairly well with those computed in the reviewed paper. However, there was disagreement of 129 to 159 per cent in torsional moments. Experimental and analytical reasons for this disagreement are presented. W. P. Welch, USA

Elasticity Theory

(See also Revs. 19, 20, 23, 29, 50, 130, 142)

11. F. G. Monge, "Study of stresses and strains produced by a bar axially loaded, and welded to a semi-infinite plate (Estudio de barra sometida a esfuerzo axial, soldada a una placa semiindefinida)," *Inst. técn. Constr. Edific. Publ.*, no. 59, pp. 3–27 (rec'd July 1948).

To determine the stress distribution along a bar welded to a semi-infinite plate at right angles to the free edge of the plate, and subjected to an axial load in the plane of the plate, the author starts with the known solution for the stress distribution in an infinite plate subjected to a surface traction at one point. Normal and shearing stresses are evaluated along a line in the infinite plate corresponding to the edge of the semi-infinite plate. Stresses within the plate developed by forces equal and opposite to these normal and shearing forces may be found, and the stresses in a plate having a free boundary are found by superposition. This gives the stress distribution resulting from traction applied at a point a known distance from the boundary of the semi-infinite plate.

A series of these tractions are applied along a line corresponding to the position of the welded bar, and the resulting strains made consistent with the strains developed in the bar as the load is transferred from the bar to the plate. A numerical procedure employing a network is utilized for some of the stress calculations.

Stress-distribution diagrams are shown, indicating that maximum stresses in the plate are developed a short distance from the edge of the plate. Glenn Murphy, USA

Experimental Stress Analysis

(See also Rev. 37)

12. D. J. Coolidge, Jr., "An investigation of the mechanical and stress-optical properties of Columbia resin, CR-39," *Proc. Soc. exp. Stress Anal.*, 1948, vol. 6, no. 1, pp. 74–82.

The material which is chemically termed allyl diglycol carbonate was studied with regard to its possible use in two and three-dimensional photoelasticity. For two-dimensional work its use seems possible, although it shows pronounced strain and optical creep (its fringe order increases by about 14 per cent in

thirty minutes). The stress-fringe relationship is approximately linear up to 2500 psi, with a stress-optical constant of about 75 psi per in.

For three-dimensional photoelasticity this plastic has several disadvantages, in particular an important tendency for relaxation of the frozen stresses. The material is also very brittle compared to other well-known resins used in photoelasticity.

Manuel Rocha, Portugal

13. **Gotthard V. A. Gustafsson, "Some basic characteristics of wire strain gauges and bridge circuits for these gauges"** (in English), *Flygtekn. Försöksanst. Medd.*, no. 22, 1947, pp. 1–17.

A theoretical treatment of the strain sensitivity of wire strain gages is presented by the author. This treatment is based upon a detailed analysis of the effects of the constants of the measuring galvanometers and associated elements in the ordinary electrical bridge circuits, with particular reference to possible errors resulting from the use of approximate formulas.

W. H. Sparing, USA

14. **W. R. Campbell, "Tests of six types of Bakelite-bonded wire strain gages,"** *Nat. adv. Comm. Aero. tech. Note*, no. 1656, July 1948, pp. 1–29.

Test results are given for six types of multistrand single-element Bakelite-bonded strain gages subjected to a variety of temperature and current conditions. The change in calibration factor due to temperature was found to vary from zero up to 9 per cent for temperatures below 140 C. The differences between the unit changes in gage resistance among ten sample "advance" gages did not exceed 0.02×10^{-4} per degree C, and for isoelastic gages 0.15×10^{-4} per degree C. The gage resistance was found to vary almost linearly with power dissipated.

D. Rubinfien, USA

15. **R. Weller and B. M. Shepard, "Displacement measurement by mechanical interferometry,"** *Proc. Soc. exp. Stress Anal.*, 1948, vol. 6, no. 1, pp. 35–38.

The mechanical interference of lines ruled on a specimen and on a transparent reference screen is used for measuring displacement or deflection. A parallel beam of light is passed through the specimen and screen, and the interference of the lines, due to displacements, is indicated by a series of light and dark areas, that is an interference fringe system, the fringes of which are readily counted. The technical information required for using this method and interpreting the results is presented, and several examples are discussed. A. N. Zamboky, USA

16. **A. Boodberg, E. D. Howe, and B. York, "Stability of SR-4 electric strain gages and methods for their waterproofing and protection in field service,"** *Trans. Amer. Soc. mech. Engrs.*, Nov. 1948, vol. 70, pp. 915–922.

Experiments with SR-4 electric strain gages are described to study their stability with respect to changes in temperature and humidity. Most of the gages were attached to steel blocks during the tests and not subjected to loads. Several waterproofing agents were tested. The results indicate that under the above mentioned conditions the stability of the gages can be maintained over long periods of time. R. K. Bernhard, USA

17. **A. E. McPherson, "Device for measuring principal curvatures and principal strains on a nearly plane surface,"** *Nat. adv. Comm. Aero. tech. Note*, no. 1137, Feb. 1947, pp. 1–22.

An instrument for determining bending stresses on plates by measuring curvatures and strains on one side of the plate is described. It uses a Tuckerman autocollimator for measuring the curvatures along three lines at 120 deg to each other, and Tuckerman gages for determining the strains along three other similar lines. Equations are given computing the median fiber strains from these measurements.

Detail drawings of the instrument and a calibration procedure are included. Experimental checks of its accuracy are presented.

Ernesto Saleme, USA

Rods, Beams, Shafts, Springs, Cables, etc.

(See also Revs. 24, 45, 58)

18. **Ernst Kreissig, "The rectangular hollow beam (Der Rechteck-Hohlträger),"** *Glasers Ann.*, Dec. 1947, vol. 71, pp. 222–226.

Long beams whose cross sections are hollow, but are not circles or regular polygons, require stiffeners at frequent intervals to prevent distortion of the cross section if they are to carry torsion. The author presents an approximate method, based on elementary stress and displacement relations, whereby the stiffener spacing may be determined.

The development involves the use of Bredt's theory, the simplest relations between displacement and strain energy, and simple relations between the cross-sectional distortion and the wall stresses. The formulas derived require a minimum of computation, and yield results which appear reasonable for the stresses in the beam walls and the required stiffener spacing. No criterion is included, however, as to the required stiffness of the stiffener elements. Joseph S. Newell, USA

19. **S. Ghosh, "On the flexure of a beam whose cross section is bounded partly by a straight line"** (in English), *Bull. Calcutta math. Soc.*, June 1948, vol. 40, pp. 77–82.

The Saint Venant flexure problem can be reduced to the determination of functions which are harmonic in the beam cross section and which take prescribed values on the boundary. Conformal transformation into a circle permits writing an immediate solution in integral form.

In this paper the author gives a corresponding solution for a cross-section boundary consisting of a curve and a straight line (for instance a semicircle), for which doubling by reflection about the line produces a curve which is easily transformed. This solution is based on the Schwarz reflection principle. The method is illustrated by re-solving the problem of the semicircle.

J. N. Goodier, USA

20. **Tadasi Isibasi, "On the form-factors of a round bar with a diametrical circular hole"** (in English), *Memo. Fac. Engng. Kyushu Univ.*, 1947, vol. 10, no. 3, pp. 165–193.

The stress concentration (form) factor is computed for bending and for torsion of a circular bar with a circular diametral hole, as a function of the ratio of hole to bar diameter. In both cases the procedure is to add: (*a*) the stress without the hole; (*b*) a plane state of stress in a strip obtained by unwrapping half the outer skin of the bar and applying stresses to the boundary of the hole which nullify the stresses present in the solid bar (this stress is approximated by expanding the sum of the principal stresses in a series of harmonic functions); (*c*) the stress produced by the resulting unbalanced moment.

As could be predicted from this intuitive approach, the stress concentration factors found are nearly the same as for plane uni-

axial tension and shear respectively. The maximum normal stress for bending is nearly $3MC/I$, C being the fiber distance where the maximum stress occurs and I being the moment of inertia of the cross section. The maximum shearing stress for torsion is nearly $2 \times 16M_t/\pi D^3$. This checks a few experimental values obtained by Peterson and Wahl, but the stress concentration factor approaches 1.0 as the hole gets larger, rather than 2.0 as suggested by Frocht [*Photoelasticity*, vol. 2, John Wiley & Sons, New York, 1948, p. 454]. D. C. Drucker, USA

21. W. William Luxion and Bruce G. Johnston, "Plastic behavior of wide flange beams," *Weld. Res. Suppl.*, Nov. 1948, vol. 13, pp. 538–554.

The authors tested wide flange sections as simple beams. The tests included two weights of eight-inch WF beams. Third point loading was used to provide a central section without shear. The flexural behavior in the elastic and inelastic ranges was studied. In addition, the effects of residual strains caused by rolling were considered by including annealed specimens (annealed after welding of test fixtures).

An extensive exploration of strains was made. Curves are presented showing the distributions of measured strains at various stations of the beams, under various loads. A nonlinear distribution of strains through the depth of the beam was observed in the inelastic range.

Experimental curves relating moments with angle changes are compared to those obtained by computations based on tensile and compressive stress-strain diagrams. The authors report that the flanges of the WF sections became completely plastic at moments 5 to 15 per cent larger than the maximum elastic moment. The angle changes along the central section then increased very rapidly at nearly constant moment. Local buckling of flanges was apparently unimportant.

The authors conclude that the relationship between moments and angle changes for such structural shapes may be calculated satisfactorily from the stress-strain curves and the usual theory of plastic bending. The tests gave no evidence of increased upper yield point or increased bending strength due to the nonuniform stress distribution in bending. Frank Baron, USA

Plates, Disks, Shells, Membranes

(See also Revs. 18, 30, 31, 32, 33, 34, 35, 36, 46)

22. R. A. Adadoorov, "Stresses and deformations in a cylindrical shell with rigid cross sections" (in Russian), *Notes Acad. Sci. USSR* (*Doklady Akad. Nauk SSSR*), Sept. 11, 1948, vol. 62, pp. 183–186.

The author considers here a thin shell reinforced over its whole length with diaphragms which are rigid in their own plane and flexible in the perpendicular direction. The stresses in this shell are produced by a twisting moment, by longitudinal forces on the surface and by forces acting perpendicular to the end sections of the shell. The paper contains the equations of equilibrium of a shell element, the determination of the boundary conditions and the general solution of the principal equations.

Witold Wierzbicki, Poland

23. W. Leutert, "The thick hemispherical shell under a snow load (Die dicke Halbkugelschale unter Schneedruck)," *Schweiz. Arch.*, Oct. 1948, vol. 14, pp. 315–319.

An exact solution of the equations of elastic equilibrium is given for a thick hemispherical shell under a loading condition in which the outer surface is subjected to a purely normal pressure corresponding to a snow loading of uniform vertical thickness, while the inner surface is free from traction. The rim is assumed to be supported on a frictionless horizontal plane. The solution is obtained by a linear combination of six elementary particular solutions. W. G. Bickley, England

24. Filippo Arredi, "On the static calculation of pipes reinforced by rings (Sul calcolo statico dei tubi cerchiati)," *Energia Elett.*, Aug. 1948, vol. 25, pp. 437–442.

This paper considers a circular cylindrical pipe reinforced periodically by rings of uniform cross section. It summarizes and completes a previous theory of the author, and considers two hypotheses concerning the forces between the wall of the pipe and the rings. In the first these forces are assumed to be concentrated in the plane of symmetry of the rings, while in the second they are considered to be uniformly distributed over the contact surface between wall and ring, actual conditions lying between these extremes. Two cases are investigated under each hypothesis: a reinforced pipe under uniform internal pressure, and an empty pipe stressed because of an initial difference between the diameters of pipe and rings. Expressions for the stresses and displacements are derived and tabulated.

It is found that the hypothesis of distributed reactions gives under all conditions the largest stresses in the rings, as well as the largest pipe stresses for the case of the empty pipe. For the pipe under uniform pressure the hypothesis which leads to the largest stress depends on the dimensions.

An equivalent modulus and thickness are derived for a case of sudden pressure application, such as would be caused by water hammer. Bruno A. Boley, USA

25. H. W. March, "Effects of shear deformation in the core of a flat rectangular sandwich panel," *For. Prod. Lab. Rep.*, no. 1583, May 1948, pp. 1–31.

This report is one of a series on buckling of flat sandwich panels prepared by the Forest Products Laboratory. The report determines the effect of transverse shear deformation in: (1) reducing the compressive buckling load of rectangular panels subject to each of four different edge conditions; (2) increasing the central deflection of rectangular panels under uniform transverse loads, subject to the condition that all edges are simply supported or clamped.

In analyzing the problems and developing formulas the authors have employed methods similar to those of H. G. Hopkins and D. M. Leggett. They have extended the analysis to apply to sandwich constructions having orthotropic facings and cores.

E. A. Brittenham, Jr., USA

26. A. Gleyzal, "Plastic deformation of a circular diaphragm under pressure," *J. appl. Mech.*, Sept. 1948, vol. 15, pp. 288–296.

In this paper a theoretical solution for the plastic deformation of a circular diaphragm under lateral pressure is obtained and compared with experimental results. The solution is based on a "deformation-type" theory in which the material is characterized by a functional relationship between the octahedral shear stress and the octahedral shear strain, the relationship being obtained from a tension test. The strain is defined in the conventional fashion and the displacements are assumed to be small, although the results agree well with the experiments for lateral deflections as large as 30 per cent of the diaphragm radius.

The author develops the problem in polar co-ordinates and reduces it to four equations with four unknowns which are solved numerically. The results are compared with experiment and show good agreement. It would appear that this paper offers

additional evidence of the usefulness of the deformation theory in obtaining engineering answers to problems in plasticity in which the principal axes of stress and strain are known to coincide.

Paul F. Chenea, USA

27. K. Goriupp, **"The rectangular plate supported on three sides (Die dreiseitig gelargerte Reckplatte),"** *Ingen.-Arch.*, 1947, vol. 16, no. 2, pp. 77–98.

In this paper the author first develops expressions for the deflection, moments, shears, etc., in a plate with three simply supported edges and one free edge under a concentrated load at an arbitrary point and under certain specified distributed loading conditions. Tables and charts at the end of the paper give critical values somewhat smaller than those found for equivalent loading conditions by I. G. Boobnov and B. G. Galerkin [see S. Timoshenko, *Theory of Plates and Shells*, McGraw-Hill Book Co., New York, 1940, pp. 218–219]. The boundary conditions developed by the author (Equations 12 and 13) are not in agreement with those commonly used. Ernest F. Masur, USA

Buckling Problems

(See also Rev. 25)

28. Sidney Cornell, **"The collapse of long cylindrical shells under external pressure,"** *Proc. Soc. exp. Stress Anal.*, 1948, vol. 6, no. 1, pp. 111–114.

This paper deals mainly with the results of an experimental investigation of the collapse of cylindrical shells of high length versus diameter ratio under external pressure.

The 258 specimens were made of high-brass tubing, with an inside diameter of 0.250 in., over-all length from $1^1/_2$ in. to $3^1/_2$ in., and wall thicknesses from 0.005 in. to 0.0125 in. The ends of the tubes were closed with a brass plug at each end. The results, given as median values and interquartile ranges, are given in a table and chart, and are correlated with an approximation of the general equation of von Mises for a tube with supported edges at its ends. It was found that for the specimens tested the length which should be used in the formula to obtain the best correlation was 0.27 in. less than the actual length inside the plugs. There seemed to be no difference between the effect of soldered-in plugs as compared with lacquer-sealed plugs. The author notes that the general effect of end constraint on effective length is worthy of further study. W. L. Esmeijer, Holland

29. E. Mettler, **"A theory of the stability of elastic displacement (Eine Theorie der Stabilität der elastischen Bewegung),"** *Ingen.-Arch.*, 1947, vol. 16, no. 2, pp. 135–146.

A general theory is given for the stability of elastic displacement of bodies subjected to body and surface forces and made of isotropic material obeying Hooke's law. The analysis is three-dimensional, and rectangular Cartesian co-ordinates are used. An important feature is that the dynamic case is taken as fundamental, and the static case as a specialization.

The analysis, which is straightforward, proceeds as follows: The Lagrangian function of the system is found correct to terms in the strains which depend on quadratic terms in the first-order partial differential coefficients of the components of displacement u_i. Hamilton's variational principle is then used to obtain the equations of motion of the system, and these equations (together with the equations which represent the boundary conditions) are the fundamental nonlinear elastic equations. If $u_i^{(0)} + \bar{u}_i$ (where $u_i^{(0)}$ is a particular integral of the above equations after their linearization in the u_i's) is a possible displacement, then, after substitution in the above equations and subsequent linearization in the u_i's, it is found that the u_i's satisfy a set of second-order partial homogeneous linear differential equations. These equations (together with certain additional equations which represent boundary conditions) involve coefficients which are dependent on the $u_i^{(0)}$'s, and are the fundamental stability equations.

In the statical case, the final problem is to find the eigenvalues and eigenfunctions of these equations; in the dynamical case it is assumed that $u_i = U_i \cos(\omega t)$, and the final problem is then of the same type. As an example, an analysis is given of the particular problem of a rectangular bar under end couples.

H. G. Hopkins, England

30. M. Milosavljevitch, **"On the stability of rectangular plates reinforced by stiffeners and subjected to bending and shearing (Sur la stabilité des plaques rectangulaires renforcées par des raidisseurs et sollicitées à la flexion et au cisaillement)"** (with summaries in German and English), *Publ. int. Ass. Bridge Struct. Engng.*, 1947, vol. 8, pp. 141–160.

In this paper the buckling load is calculated for a thin rectangular plate stiffened in two directions by reinforcing bars. It is assumed that there are two such bars parallel to the y-direction, which divide the plate into three equal parts, while one arbitrarily placed bar parallel to the x-direction is considered. The structure is assumed to be under simultaneous shear, and bending and compression in the x-direction, all in the plane of the plate.

In the solution the deflections are assumed in terms of a double Fourier series, and the stability determinant is then established with the aid of the plate differential equation of equilibrium. The reactions transmitted to the plate by the reinforcing bars are also expressed by a double Fourier series (the coefficients of which are related to those of the series for the deflections) and are treated as external loads on the plate.

General equations are first derived, and then the particular cases of pure bending and of bending plus shear are considered in detail. Numerical results of practical interest are presented in tabular form for these two cases, for several values of the parameters involved. Numerical examples are included.

Bruno A. Boley, USA

31. E. W. Kuenzi, **"Stability of a few curved panels subjected to shear,"** *For. Prod. Lab. Rep.*, no. 1571, May 1947, pp. 1–23.

Curved plywood panels were subjected to shearing loads from which the critical buckling stress could be evaluated. These results indicated that the buckling stress of a curved panel in shear is approximately equal to the sum of the buckling stress for a complete cylinder of similar material in torsion and that for a flat plate of the same dimensions in shear. Tests on a single plate of sandwich type of construction gave similar results.

Louis F. Coffin, Jr., USA

32. Ch. Dubas, **"A contribution to the study of buckling of stiffened plates (Contribution à l'étude du voilement des tôles raidies)"** (with English and German summaries), *Publ. int. Ass. Bridge Struct. Engng.*, 1948, Third Congress, prelim. publ., pp. 129–136.

The method of finite differences as applied to plate problems is used in this paper. The particular problem of buckling of a web which is under pure bending and stiffened longitudinally by a single stiffener, is investigated in detail.

Curves of the instability coefficient k as a function of the aspect ratio of the web are presented for various values of the ratio of bending rigidity of the stiffener to that of the plate, and for values

of 0 and 0.1 of the ratio of stiffener area to plate area. No consideration is given to the effect of stiffener torsional rigidity. As a check several values of k were calculated by the energy method.

The results of this investigation indicate that in most cases, the stiffener should be located at the upper fifth of the web for optimum effect. With the stiffener so located, the instability coefficient is increased approximately 500 per cent over that for an unstiffened web. George Gerard, USA

33. K. H. Boller, "Buckling loads of flat sandwich panels in compression," *For. Prod. Lab. Rep.*, no. 1525-A, Feb. 1947, pp. 1–53; no. 1525-B, Sept. 1947, pp. 1–25; no. 1525-C, Sept. 1947, pp. 1–16; no. 1525-D, Sept. 1947, pp. 1–15; no. 1525-E, Mar. 1948, pp. 1–10.

These reports describe tests made on sandwich panels with various edge conditions. Panels with cores of either end-grain balsa or cellular cellulose acetate, and faces of either aluminum or glass-cloth laminate, were tested with all edges simply supported, either the loaded or the unloaded edges simply supported and the others clamped, and all edges clamped. Report E describes tests on panels of paper honeycomb cores and glass-cloth laminate faces, with all edges either simply supported or clamped.

The experimental results are compared with theoretical values given by formulas derived in a previous report by H. W. March and C. B. Smith ["Buckling loads of flat sandwich panels in compression—various types of edge conditions," *For. Prod. Lab. Rep.*, no. 1525, Mar. 1945]. Modifications are made in these formulas to account for the effects of transverse shear deformations in the cores and of stresses exceeding the proportional limit. Reasonable agreement is obtained between the experimental and the modified theoretical values; it is usually somewhat better for the panels with all edges simply supported than for those with all edges clamped. The theoretical buckling stresses are in general higher than those observed, the difference being about 20 per cent of the theoretical value in the worst case.

The experimental buckling load was taken both as the load at the point of inflection of the load-deflection curve, and as the load at the point of reversal of the stress-load curve. It is shown that there is good agreement between the results given by these two methods.

A detailed description is given of the preparation of test specimens, of the test apparatus and procedure, and of related tests run to determine the physical properties of the various materials. Bruno A. Boley, USA

34. T. B. Heebink, H. W. March, C. B. Norris, C. B. Smith, and L. A. Ringelstetter, "Buckling of stiffened flat plywood plates in compression," *For. Prod. Lab. Rep.*, no. 1553, June 1946 (issued in 1947), pp. 1–33; no. 1553-A, Nov. 1946 (issued in 1947), pp. 1–22; no. 1553-B, May 1947, pp. 1–52.

The authors develop a theory for buckling in one wave across the stiffener, in two waves on either side of the stiffener and combinations of these. The variation in buckling shape as the stiffener size is varied is illustrated for a particular panel, and a general formula for minimum stiffener size to prevent buckling across it is obtained and compared with the results of several hundred tests. The need of an empirical factor to make the theoretical strengths agree with the experimental strengths is attributed to initial curvature of the panels. In the second paper the authors extend the previous study to plywood panels in which the face grain is oriented 45 deg to the edges. The analytical results are checked by a series of tests in which the critical stress is obtained by the "strain difference" method—that is, the difference in the strain measured just below the stiffener at the edges and at the center of the panel is plotted as a function of the load. The apparent critical load is taken as the load when the plot ceases to be linear. Since the critical load thus obtained does not agree with that obtained with the more precise procedure of *For. Prod. Lab. Rep.*, nos. 1316B and G, a set of correction factors are derived.

In the third paper a mathematical analysis is made of the critical stress of a plywood plate in edge compression, stiffened by means of a single stiffener glued to the panel in the direction of the loading. An energy method is used and the lack of original flatness of the panel and the torsional stiffness of the stiffener are neglected. The grains of the plies are assumed to be 0 deg or 90 deg to the stiffener, and the plywood to act as an orthotropic material. The solution derived can be used to determine the size of stiffener necessary for the panel to buckle into two waves on each side of the stiffener.

Extensive tests were performed to check the validity of the theory. The method used to determine the critical load in this case was to plot the strain, as determined by a strain gage mounted along a diagonal at a quarter point, against the load. This method gave close agreement with the theoretical results. Frank J. Mehringer, USA

35. Roger W. Peters, "Buckling tests of flat rectangular plates under combined shear and longitudinal compression," *Nat. adv. Comm. Aero. tech. Note*, no. 1750, Nov. 1948, pp. 1–14.

An experimental investigation was made to determine the validity of a parabolic interaction curve for elastic buckling of a long square box, formed by joining flat rectangular plates with riveted corner angles, and loaded with various ratios of longitudinal compression and torsion. Although a certain amount of scatter was observed, the experimental points fell reasonably close to the assumed interaction curve. John E. Goldberg, USA

36. C. B. Norris and L. A. Ringelstetter, "Buckling of stiffened flat plywood plates in compression—a single stiffener parallel to stress, face grain of plywood at 45 deg to its edges," *For. Prod. Lab. Rep.*, no. 1553-C, Oct. 1948, pp. 1–13.

Results of 38 edgewise compression tests on rectangular plywood plates having face grain at 45 deg and reinforced by a single central stiffener in the direction of the load lead to the empirical formula for the critical stiffness of the stiffener $EI = 0.15/\pi^2 hab^2 (\sigma_{cr2} - \sigma_{cr1})$ where h, a and b are the thickness, length of loaded side, and length of unloaded side, σ_{cr1} is the compressive buckling stress of the unstiffened panel, and σ_{cr2} is the buckling stress of the stiffened panel. A stiffener selected on the basis of the above formula can quadruple the buckling stress. John E. Goldberg, USA

Structures

(See also Revs. 22, 24, 54, 59)

37. Domenico G. Silverj, "A photoelastic research on closed frames" (Una ricerca fotoelastica su telai chiusi), *G. Gen. civ.*, Mar.-Apr. 1948, vol. 87, pp. 149–159.

Using xylonite models and photographing isoclinics, the author determined the isostatics for three rectangular closed frames subjected to uniformly distributed external pressure. The ratios of the height to the width of the frame sides were 1/4, 1/8, and 1/16. For the second case the photoelastic results are compared with theoretical calculations.

The very lengthy point-by-point determinations could have been avoided by using brittle coatings instead of photoelasticity.

This would also have eliminated the error introduced by the residual stresses of the model. A. J. Durelli, USA

38. **P. W. Abeles, "The development of prestressed concrete,"** *Civ. Engng. Lond.*, 1948, vol. 43: Jan., pp. 26–29; Feb., pp. 86–90; Mar., pp. 145–150; Apr., pp. 200–206; May, pp. 248–251, 261; June, pp. 306–312; July, pp. 358–364; Aug., pp. 414–418; Sept., pp. 464–470; Oct., pp. 519–524.

This is a general review of prestressed concrete principles, properties, methods and calculations. Although no results of new tests are shown, the field is covered thoroughly and the bibliography is up to date. The author emphasizes the difference between pretension and posttension prestressed concrete, and compares the different techniques in use from several points of view. An analysis is made of several applications, and general conclusions are drawn. A. J. Durelli, USA

39. **Millard V. Barton, "Fundamentals of aircraft structures,"** Prentice-Hall Inc., New York, 1948. Cloth, 9.2 × 6 in., 298 pp., 188 figs.

This should serve well for a brief first course in aircraft structures. Following a discussion of the basic loads on aircraft and a review of strength of materials, the text develops standard methods for the routine aircraft structural problems. The stability of struts and beam-columns is covered but the discussion of thin-sheet problems is brief. Charts are included for solving several more difficult problems. John E. Goldberg, USA

40. **John H. Bateman, "Introduction to highway engineering,"** John Wiley & Sons, New York, 1948. Cloth, 9.2 × 5.8 in., 538 pp., 171 figs., $5.50.

Newly added features of this fifth edition include added information on "pumping" action of concrete pavements, recent load-deformation data on various subgrades and the most recent soil-classification system of the Highway Research Board. The chapter on drainage gives cumulative grain-size charts for the design of filter material for blind drains and porous backfill around pipe drains. Eben Vey, USA

Rheology (Plastic, Viscoplastic Flow)

(See also Revs. 21, 26, 60, 67)

41. **G. I. Taylor, "The formation and enlargement of a circular hole in a thin plastic sheet,"** *Quart. J. Mech. appl. Math.*, Mar. 1948, vol. 1, pp. 103–124.

When a circular hole is made in a flat sheet by a rotating conical-headed bullet or by uniform outward radial pressure on the edge of the hole, the metal near the hole may pile up into a thickened crater in one of two ways: the thickening may occur symmetrically on both sides of the sheet, or the thickening may occur unsymmetrically on only one side of the sheet. The author chooses to discuss in detail the mechanics of deformation of the symmetrical case. It is assumed that the bullet exerts no force in an axial direction.

The difficulty of the problem lies in the fact that the complete strain history of each element of the sheet has to be calculated. This is because the ratios of the principal stresses at each element of the sheet vary as the deformation proceeds, so that there is a relationship only between stress and strain increments occurring during a small expansion of the hole, and not between stress and total deformation.

The author summarizes an unpublished analysis of this case by H. A. Bethe, in which Mohr's condition of plastic flow is satisfied. He explains discrepancies in the assumptions made and improves this analysis by applying the von Mises theory of yielding. The strain history is followed on this new basis and compared with Bethe's results.

If b is the radius of the hole at any time, the strains are elastic in regions with radius $r > 3.64b$, the plastic strains can be considered to be small within the annular region $2.21b < r < 3.64b$, while finite strains occur in the annular region $b < r < 2.21b$. At the edge of the hole the author's analysis shows that the sheet has thickened to 2.61 times the original thickness of the sheet.

Experiments with holes produced in lead sheets by a rotating and well-lubricated conical broach of 3-deg included angle show that the symmetrical deformation contemplated by the author's analysis does not actually occur. The alternative unsymmetrical deformation is produced, especially after the hole has been enlarged between seven and ten times the thickness of the sheet, at which time the sheet bends out of its plane. This bending is not produced by an axial thrust from the broach because the sheet sometimes bends toward the thick end of the broach and sometimes away from it. Calculations show that this unsymmetrical mode requires less work, in the ratio 2.6 to 1.0, than the symmetrical mode. Paul R. Shepler, USA

42. **G. J. Dienes, "Viscoelastic properties of thermoplastics at elevated temperatures,"** *J. Colloid Sci.*, Feb. 1947, vol. 2, pp. 131–161.

The author reviews the general theory of linear viscous elasticity, and goes on to compare it with some results obtained on a parallel plate plastometer. Plastics studied included cellulose ester vinylites, and polyethylene. Only the simplest Maxwell and Voigt units are used in the actual analysis, and agreement with the data is quite fair. Four constants characterize two springs and two dashpots. George Halsey, USA

43. **A. N. Gerasimov, "Generalization of linear deformation laws and application to problems of internal friction"** (in Russian), *Appl. Math. Mech.* (*Prikl. Mat. Mech.*), May-June 1948, vol. 12, pp. 251–260.

The flow of a Boltzmann material between parallel plates and the flow between coaxial cylinders is treated by operational calculus. W. Prager, USA

44. **A. G. Ward, and P. R. Freeman, "The rheology of stiff pastes,"** *J. sci. Instrum.*, Nov. 1948, vol. 25, pp. 387–396.

Two concentric cylinder viscometers suitable for studying the flow of stiff pastes are described. Some experimental results are presented, and are discussed from the standpoint of Bingham's law. George Halsey, USA

45. **L. M. Kachanov, "Plastic torsion of round rods with varying cross sections"** (in Russian), *Appl. Math. Mech.* (*Prikl. Mat. Mekh.*), July-Aug. 1948, vol. 12, pp. 375–384.

Using stress-strain relations of the deformation type for a work-hardening plastic material, the author discusses the torsion of a shaft of variable diameter. The differential equation of the stress function is established (Monge-Ampère type) and the equivalent variational principle is discussed. The author discusses in detail the cases of: (1) a nearly cylindrical shaft; (2) a thin-walled hollow shaft of variable diameter; (3) a thick-walled hollow shaft which does not deviate much from a cylindrical tube.

The general equations are not evaluated to an extent where it could be readily decided whether A. A. Ilyushin's condition for the

applicability of the deformation type of stress-strain law [*Appl. Math. Mech.* (*Prikl. Mat. Mekh.*), 1945, vol. 9, pp. 207–218] is at least approximately satisfied. However, since this condition is known to be satisfied for the torsion of a solid cylinder or a cylindrical tube, the results obtained for the cases (1) and (3) above may be expected to constitute reasonably good approximations. The stress distribution in case (2), on the other hand, is statically determinate and hence independent of the stress-strain law.

W. Prager, USA

46. Y. N. Rabotnov, "On the disk of equal resistance" (in Russian), *Appl. Math. Mech.* (*Prikl. Mat. Mekh.*), July-Aug. 1948, vol. 12, pp. 403–404.

A compressible elastoplastic disk, of variable small thickness h, is rotating at a uniform angular speed ω about its axis of revolution. The author considers this as a two-dimensional problem and states, without giving references, that for a zero hole radius the principal stresses σ_1 and σ_2 are equal if the dependence of the thickness on the radius r is given by $2\sigma_i \log (h/h_0) = -\rho\omega^2 r^2$ (where ρ is the density and $\sigma_i^2 = \sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2$), and that for the case of a finite hole the stresses cannot be isotropic.

The author then shows that if the hole radius a is finite but small, the same disk profile yields (for $r/a \to \infty$), constancy of σ_i, which for $r/a \to \infty$ implies that $\sigma_1 - \sigma_2 \to 0$. The stress-strain relations of A. A. Ilyushin [*Appl. Math. Mech.* (*Prikl. Mat. Mekh.*), vol. 7, no. 4, 1932] are used. For the incompressible case manageable formulas are given for finite r. Graphs of σ_1, σ_2 and $\log (h/h_0)$ versus r/a are shown.

A. W. Wundheiler, USA

47. F. K. Th. van Iterson, "Plasticity in engineering," Blackie & Son, London, 1947. Cloth, 8.8 × 5.8 in., 174 pp., 136 figs., 8s. 6d.

In the first half of his book the author presents an excellent review of problems in two-dimensional plasticity. His method of approach is that developed by Hencky in 1921. Although, as Iterson demonstrates, this method may be applied with comparative ease to a large number of problems, it has been practically unrecognized in the United States. Adequate recognition of this method would have prevented some of the misconceptions regarding the state of stress at notches in tensile tests, misconceptions which were initiated by Kuntze in 1932 and are still prevalent. All interested in the plastic behavior of materials will find this book of great value.

In the second half of his book, the author discusses problems in three-dimensional plasticity. In this discussion he utilizes an assumption regarding the intermediate principal stress, which does not rest upon a firm foundation, namely the assumption that the intermediate principal stress rapidly approaches either the lower or the upper principal stress as deformation proceeds.

Clarence Zener, USA

48. R. L. Woolley, "Work-hardening in polycrystalline pure metals," *Rep. Conf. Strength Solids, Univ. Bristol*, July 1947 (publ. in 1948), Physical Society, London, pp. 51–56.

Three theories of work-hardening in metals are examined: (1) The "exhaustion" theory assumes the existence throughout a metal of small regions of high internal stress-pairs—tension and compression—from each of which a dislocation can be started and caused to pass to a crystal boundary by application of a particular value of external stress, its "activation" stress (whose sign is immaterial since it affects a stress-pair). The higher the external stress the greater the number of stress concentrations affected, and used up; hence the name of the theory. (2) The "hardening" theory assumes the existence of stress concentrations distributed as before but all with roughly the same activation stress. When this is reached all sources give rise to dislocations which are activated to some extent but which then require an increased external stress for further activation, and so on. (3) The "crystallite" theory of Sir W. L. Bragg assumes that with plastic flow the size of crystallites is reduced, the size thus being a function of external stress.

The author decides from tests on twisting and untwisting copper tubes that the stress-strain relation obtained for reversed loading has certain similarities to that which would obtain for restressing in the original direction. He concludes that for unidirectional stressing there is little choice among the theories, but that the behavior during reversed stressing is best explained by the exhaustion theory, although all three processes may occur together.

M. P. White, USA

49. C. L. Smith, "A theory of transient creep in metals," *Proc. phys. Soc. Lond.*, Sept. 1948, vol. 61, pp. 201–205.

The author derives a theoretical expression for the rate of primary (transient) creep by assuming: (1) that the distribution of submicroscopic spots of stress concentration in a metal is a function of activation energy and time; (2) that transient creep is dependent on the number of these spots; (3) that these spots are continuously depleted during the creep process; and (4) that simple functions of energy describe the distribution of spots at the start of creep. The rate of creep is found to be proportional to the product of the absolute temperature by the quantity, $(1 - e^{-Ct})/t$, where C is a constant, and t is the time.

A. R. Bobrowsky, USA

50. J. E. Dorn and A. J. Latter, "Stress-strain relations for finite elastoplastic deformations," *J. appl. Mech.*, Sept. 1948, vol. 15, pp. 234–236.

The authors develop stress-strain relations for elastoplastic deformations for strain magnitudes large enough so that the equations based on infinitesimal strains are no longer valid. Only isotropic materials are considered and constancy of volume is assumed.

They first develop the equations of finite strain in any continuous medium in a purely geometrical manner by means of a Lagrangian transformation, and then take up the development of the particular equations of elastoplasticity. The authors are careful throughout the development to indicate where assumptions have been made, and to justify these assumptions in terms of simplicity gained in a first analysis, lack of experimental data, or the relatively small effect of using more general assumptions.

The authors point out that because of the difference in relationships of elastic infinitesimal strains to stress and plastic infinitesimal strains to stress, isotropic materials evidence a sort of anisotropy in the elastoplastic range, except for the case when the stress ratios are constant throughout the deformation.

Morton B. Millenson, USA

51. F. R. N. Nabarro, "Deformation of crystals by the motion of single ions," *Rep. Conf. Strength Solids, Univ. Bristol*, July 1947 (publ. in 1948), Physical Society, London, pp. 75–90.

The author discusses the effect of the movement of vacant lattice sites (holes) and interstitial ions on the deformation of crystals. For perfect crystals under shear stress, consideration of the diffusion of holes toward or away from the loaded surfaces indicates that for this kind of deformation mechanism, the creep rate depends on the size of the specimen. Comparison with experi-

mental data on the creep rate of single crystals of tin indicates that the observed creep rate cannot be explained by the mechanism of hole diffusion if the specimen is effectively a single crystal (not a mosaic structure of crystallites). However, the assumption of a mosaic structure leads to difficulties in explaining the observed limiting total creep, which was found to be independent of stress.

Effects at grain boundaries are also discussed as well as the effect of nonuniform stress. Finally a survey is made of creep phenomena to be expected as a result of neutron bombardment which may produce vacant lattice sites and motions of interstitial ions. The effect of such bombardment on the movement of dislocations is also discussed. A. M. Wahl, USA

52. **Franco Levi, "On the states of elastic interaction of viscous origin (Sugli stati di coazione elastica di origine viscosa),"** *G. Gen. civ.*, Feb. 1948, vol. 86, pp. 65–70.

A general expression for deformation in a homogeneous solid is developed as the sum of the elastic deformation and a viscous deformation which is assumed to be a linear function of stress and an exponential function of time. The author then applies a theorem attributed to Colonnetti, minimizing the total energy of the system to obtain a general equation of "viscous equilibrium" in a homogeneous elastic solid. From this is developed an equation for the variation in magnitude of any force in an indeterminate system in which viscous flow occurs. It is noted that the result is equivalent to using a reduced modulus of elasticity which is a function of time. Limiting values for infinite time are given, indicating lower moduli than obtained by previous methods.

In the second part of the paper, shrinkage effects and transverse deformation are included in the analysis. All assumptions are clearly stated, and the author comments on the practical limitations of the method and the hypotheses made.

Glenn Murphy, USA

53. **Franco Levi, "On static effects of viscous phenomena (Sugli effetti statici dei fenomeni viscosi),"** *G. Gen. civ.*, June 1948, vol. 86, pp. 317–321.

This is an extension of a previous paper by the same author (see preceding review). Application of the method to concrete structures is discussed, with emphasis on the practical aspects.

Glenn Murphy, USA

54. **F. Levi, "On static effects of viscous phenomena. Note II (Sugli effetti statici dei fenomeni viscosi),"** *R. C. Accad. Lincei*, Apr. 1948, ser. 8, vol. 4, sem. 1, pp. 424–427.

The author presents a derivation, simpler than that of his previously published Note I, of the relation between stress and time in a system which exhibits viscous behavior over long periods of time but which responds elastically to immediate loads. The long-time plastic flow, for which the law of variation with respect to time is arbitrarily assumed by the author, may be due to an initial state of stress in the system, originating from one or more dislocations.

This simplified treatment is extended to a statically indeterminate structure in which one or more supports settle in accordance with a known function of time. Edward Saibel, USA

55. **W. Siegfried, "Observations on conducting and evaluating creep tests,"** *J. Iron Steel Inst.*, June 1947, vol. 156, pp. 189–207.

The author attempts to set up a procedure for predicting the time to fracture of alloys at high temperatures (600 to 900 C) under dead load from data obtained in short-time tests. His method of attack is (1) to determine the variation of magnetic susceptibility with time at given temperature for metastable phases that transform to ferromagnetic phases, (2) to determine the notch sensitivity of materials under dead load as a function of cold-working parameters, and (3) to correlate the reduction in area versus true stress characteristic with variations in stress-rupture life, and finally, to extrapolate these data to long times of test.

A good correlation is obtained between the reduction in area versus true stress characteristic with stress-rupture life, but it is concluded that extrapolation of sustained load data is not yet feasible. A. R. Bobrowsky, USA

56. **G. S. Sangdahl, Jr., E. L. Aul, and G. Sachs, "An investigation of the stress and strain states occurring in bending rectangular bars,"** *Proc. Soc. exp. Stress Anal.*, 1948, vol. 6, no. 1, pp. 1–18.

To analyze the strain occurring in bending rectangular sections, measurements of the longitudinal and transverse strains were made, using photogrid lines. Various ratios of transverse to longitudinal surface strains were obtained by varying the breadth-to-height ratios.

It was found that the ductility, defined by the maximum longitudinal strain at fracture, was increased by decreasing the breadth-to-height ratio or the biaxiality of stress. The fracture stresses, obtained from the ductility values by means of a universal stress-strain relation, were not in agreement with other data relating fracture stress and biaxiality.

Since the material used in the investigation was not isotropic, certain approximations were necessary to allow for the anisotropy.

H. M. Schnadt, Luxemburg

Failure, Mechanics of Solid State

(See also Rev. 56)

57. **Georges Welter, "Two new methods for testing triaxial specimens,"** *Weld. Res. Suppl.*, Nov. 1948, vol. 13, pp. 529–536.

Triaxial tension specimens were made by machining integral threaded extensions to each of the six faces of a cubical test volume. The eight edges of the latter were then notched inward so that the actual test cube was reduced in size and appeared as a notched tensile specimen in any of the three directions. Both mechanical and hydraulic methods of loading the threaded extensions were employed.

Fracture strength values obtained were compared with others obtained on a specially prepared uniaxial specimen having notches similar in form to those of the triaxial one, with a view to shedding light on the question of whether triaxiality increases or decreases fracture strength. In general the computed tensile stress at fracture was somewhat lower in the triaxial specimen.

The reviewer is in doubt as to the exact significance of those results in view of the large stress concentrations which were present in the tests. Charles W. Gadd, USA

58. **Ambrose H. Stang and Bernard S. Jaffe, "Bending tests of large welded-steel box girders at different temperatures,"** *J. Res. nat. Bur. Stands.*, Nov. 1948, vol. 41, pp. 483–495.

Four box girders approximately two feet square with $2^1/_2$-in. cover and $1^1/_2$-in. side and bottom plates were fabricated by welding, and tested in bending at various temperatures. The two girders tested at the lower temperatures failed with a cohesive type of fracture (normal to the surface), with relatively little deflection, while those at the two higher temperatures showed higher

moduli of rupture and large deflections without fracture, as indicated in the table:

Temperature of test, F	Modulus of rupture, psi	Maximum deflection, in
—40	63,100	2.45
0	79,900	8.83
40	90,400	16.16
80	91,200	18.06

The steel was a plain low-carbon open-hearth steel fully killed, and had good notch toughness properties at relatively low temperature. Tension tests of coupons cut from the plate material did not show any significant changes in properties at the lower temperatures.

Strain-gage readings showed interesting results after the yield point was exceeded. Gages opposite a diaphragm showed much less strain in the plastic range than those not at a diaphragm. Strains indicated by gages on the bottom plate (in tension) were greater in the plate than at points in the same relative location but on a weld. Strain distribution through the depth of the beam did not remain linear after the yield point was passed, apparently due to the diaphragms. Henry A. Lepper, Jr., USA

Design Factors, Meaning of Material Tests

(See also Rev. 55)

59. Robert Lévi, "Safety of structures (La sécurité des constructions)" (with English and German summaries), *Publ. int. Ass. Bridge Struct. Engng.*, 1948, Third Congress, prelim. publ., pp. 587–601.

The problem of designing to prevent failure of a structure is considered in terms of risk; the uncertainties considered relate to strength of the material, design calculations, workmanship, and service loads. The author notes that the normal distribution law of Gauss need not be assumed to hold if some other is known to be valid. The need for an alternative to the conventional safety factor and the importance of plastic action in the metal are discussed.

The method proposed by the author for the application of these ideas consists in observing, for a critical point in a simple structure such as a beam, the service stress P and the permissible stress R. A formula is evolved for the values of the parameters relating to risk of failure. The values so found are to be taken as guides in connection with more elaborate structures.

No details of the procedure to be followed in using the method are given and no results are cited. W. P. Roop, USA

60. E. Voce, "True stress-strain curves," *Metal Treatm.*, summer quarter 1948, vol. 15, pp. 53–66, 72.

The author discusses relationships between strain and true stress (the stress at any stage of deformation expressed in terms of the actual area of the specimen at that stage). Various curves relating true stresses with strains are presented and related to the ordinary tensile properties of materials. Methods are described for determining the yield point, ordinary tensile strength, true stress at the maximum load, and the corresponding strain for any degree of cold work. In general, these methods are based on the assumption that the yield point of a cold-worked material represents the true stress to which it was subjected during cold working.

The paper outlines some experiments and procedures useful in establishing controls of cold-working operations. Such operations are illustrated by examples of wiredrawing, rolling, deep drawing, and pressworking. Curves relating true stresses with strains were obtained from several simple tests and related to the effects of cold-working operations. The author suggests that curves obtained from relatively simple tests may perhaps be applied in general to processes of deep drawing and pressworking. He further suggests that in all questions pertaining to deformations, the use of percentage reductions should be abandoned in favor of deformation ratios or logarithmic strains.

Frank Baron, USA

61. A. J. Moe, "The conception of safety (Begriff der Sicherheit)" (with English and French summaries), *Publ. int. Ass. Bridge Struct. Engng.*, 1948, prelim. publ., pp. 625–642.

After a brief historical survey of the conception of safety, the author discusses present-day safety factors applied to structural members by civil engineers all over the world. He concludes that safety on the basis of commonly used permissible stresses is inexpedient, and that the treatment of the various factors which affect safety, such as static and variable loading, stress-strain diagrams, shrinkage, creep, extreme temperature, etc., and the probability of their incidence, must be modified in order to conform to modern requirements of structural design.

He suggests new coefficients of safety which he has worked out methodically and which, in his opinion, are closer to the requirements of practice. Egon Benesi, USA

Material Test Techniques

(See also Revs. 9, 55, 56, 57, 67, 131, 138, 144)

62. R. Jones, "The dynamic testing of concrete by a supersonic method" (in English with French and German summaries), *Publ. int. Ass. Bridge Struc. Engng.*, 1948, prelim. publ., pp. 227–240.

The author's objective in conducting his research was to evaluate the possibilities of determining the properties of concrete in situ. This objective has not been realized, but a novel method of testing concrete specimens has resulted. Whereas the more common method uses ultrasonic measurements to determine the actual frequency of vibration of a beam, the author uses a series of discrete impulses at ultrasonic frequencies to measure the velocity of sound in the concrete. He has been able to distinguish the characteristics of different portions of a concrete specimen, obtaining values for the top, middle and bottom sections of a cube, and proving that the average values for entire specimens, which are commonly used, are misleading.

The author shows by his data that a relation between the velocity of sound and the strength of the concrete cannot be established until the characteristics of the aggregate and the mix have been established independently. It would appear therefore that the author's method still falls short of determining the strength of a concrete in situ by nondestructive tests.

In the conduct of his tests the author has been able to make independent evaluations of Poisson's ratio and shows that it varies from 0.16 to 0.31. This indicates the range of error in present methods which assume an average value for all conditions in the neighborhood of 0.20. Walter C. Voss, USA

63. W. Müller, "Equipment for measuring gallery expansion and determining the elasticity of rock" (in English), *Sulzer tech. Rev.*, 1947, no. 3/4, pp. 17–23.

A dilatation gage suitable for measuring changes in diameters of rock tunnels under hydraulic pressure is described. The measuring unit consists of a spring bellows set in a cylindrical vessel containing a dense colored liquid. Rods running diametrically to the walls of the tunnel deform the bellows and cause a change in volume of the cylinder, which is measured by means of a tube con-

necting the cylinder to an external manometer. The pressure at the other end of the manometer is matched to the tunnel pressure so that the whole bellows system is under uniform hydrostatic pressure.

Some information is given as to the behavior of rocks under tunnel pressure. Geological stratification caused greater vertical dilatation than horizontal in a test tunnel, resulting in a horizontal modulus of elasticity of 60,000 kg/cm² (856,000 psi) and a vertical modulus of 40,000 kg/cm² (570,000 psi). Creep of the rock was observed, and a relationship between water losses, expansion, and elasticity was also noted.

Louis F. Coffin, Jr., USA

64. E. W. Taylor, "Microhardness testing of metals," *J. Inst. Metals*, June 1948, vol. 74, pp. 493–500.

In this paper the author describes a method of microhardness testing in which an inverted Le Chatelier type of metallurgical microscope is used, with a small Vickers diamond cemented directly to the center of the face of the objective lens. The diamond is small enough so as to obscure only a small portion of the working face of the lens. The specimen is secured to one end of a carefully balanced lever, attached to the mechanical stage. Chemical balance weights may be placed on the lever so as to obtain any desired load from one to five hundred grams.

To make a hardness measurement, the specimen is located properly above the microscope. Using the slow motion, the telescope is moved up until contact is indicated and an indentation has been formed. The telescope is then lowered and the size of indentation read, using cross hairs in the microscope. After one trial indentation has been made, a cross-hair reading can be determined which indicates the point at which the indentation will come on the specimen and enables hardness readings to be taken at any desired point.

By operating the mechanical-stage mechanism, a scratch hardness test can also be made, using the same Vickers diamond. Instructions are given as to various mechanical details of operation. Photomicrographs showing typical indentations are included.

Mortimer F. Sayre, USA

Mechanical Properties of Specific Materials

(See also Revs. 42, 44, 53, 58, 62, 63)

65. W. N. Findley and W. J. Worley, "Mechanical properties of five laminated plastics," *Nat. adv. Comm. Aero. tech Note*, no. 1560, Aug. 1948, pp. 1–111.

This paper reports tests on five laminated plastics of interest in aircraft construction. The plastics were (1) canvas laminate, phenolformaldehyde resin, molded at 180 psi; (2) grade-C canvas laminate, resin formed from formaldehyde and a mixture of meta- and para-cresol, molded at 1800 psi; (3) rayon laminate of saponified acetate-type, phenolic resin, molded at 1100 psi; (4) Mitscherlich-paper laminate, phenolic resin, molded at 250 psi; and (5) glass-fabric laminate, unsaturated polyester resin, molded at 40 psi.

The tests performed were: static tension, compression, and torsion tests; creep tests at different tensile stresses; fatigue tests of notched and unnotched specimens in bending; fatigue tests in bending at −75, 77, and 160 F; and fatigue tests in torsion.

The glass-fabric laminate had the best properties except for yield strength, for which the paper laminate was superior. The grade-C canvas laminate was next best in compression strength, hardness, and torsion fatigue strength, and the rayon laminate in notch fatigue strength. The paper laminate was next best in all other properties.

Charles E. Crede, USA

66. Franz Bollenrath and Hanns Gröber, "The creep properties of certain aluminum and magnesium alloys at temperatures from 90 to 180 C (Über das Kriechverhalten einiger Aluminium- und Magnesiumlegierungen bei Temperaturen zwischen 90 und 180°)," *Metallforsch.*, Apr. 1947, vol. 2 (*Z. Metallk.*, vol. 38), pp. 104–111.

Creep rates and total elongations were determined in the temperature range of 90 to 180 C, as functions of the applied tensile stress, for wrought-aluminum alloys with 1 to 6 per cent Mg and 2 to 7 per cent Zn, for a cast aluminum alloy with 9.5 per cent Si, for wrought-aluminum alloys with 4.14 or 4.28 per cent Cu and 0.76 to 1.00 per cent Mg, as well as for two cast magnesium alloys with 5.83 or 8.53 per cent Al and 2.59 or 0.5 per cent Zn. Age-hardening curves are given. Elastic moduli of the magnesium alloys were determined at elevated temperatures. The copper-containing aluminum alloys possessed greater creep resistance than the copper-free alloys, and the magnesium alloys possessed the poorest creep resistance of all.

A. R. Bobrowsky, USA

67. S. D. Gehman, "Creep, recovery, and permanent set for GR-S and Hevea," *J. appl. Phys.*, May 1948, vol. 19, pp. 456–463.

These two types of rubber, tested at 35 C over a 1000-hour period at various elongations, possess a strongly different molecular structure. The creep values for GR-S are large at low elongations and diminish continuously for higher elongations. This behavior is consistent with a relatively unstable molecular structure of GR-S at low elongations. Hevea, on the other hand, shows low creep at both low and high elongations, and maximum creep at intermediate elongations where the structure is partly amorphous and partly crystalline. Since a special procedure was worked out to distinguish between the recoverable creep and the permanent set, it could be stated that the flow of Hevea at high elongations was entirely accounted for by permanent set.

It was found advantageous to specify the gaged length of a test piece as the distance between the ends of two lines ruled parallel to the central line of the test piece. The ends of these lines remain sharply defined, whereas the usual lines ruled across the test piece are broadened upon stretching.

J. A. Haringx, Holland

Mechanics of Forming and Cutting

(See also Revs. 47, 60)

68. Erich Siebel, "The present state of knowledge about the mechanical phenomena of wire drawing (Der derzeitige Stand der Erkenntnisse über die mechanischen Vorgänge beim Drahtziehen)," *Stahl Eisen*, May 22, 1947, vol. 66/67, pp. 171–180.

This article is an excellent review of recent developments in our understanding of wire drawing. While the author has given an analysis in which some rather broad simplifying assumptions are made, the results he obtains are fundamentally sound and consistent with experiment. His concluding charts are very interesting and may have considerable use in the actual laying out of the wire-joint sequence. A translation of this article into English would be of great value to American engineers.

R. G. Sturm, USA.

69. E. C. Helfrich, "Theory and practice of the crush-dressing operation on grinding wheels," *Trans. Amer. Soc. mech. Engrs.*, Nov. 1948, vol. 70, pp. 885–891.

This paper presents a theory of the crush-dressing process. It is based on the assumption, confirmed by experiments, that the

pressure between crush dresser and wheel is essentially a constant for a given wheel. Using certain geometric relations, the author succeeds in deriving equations for the computation of the radial force and the torque necessary to crush-dress. Experiments are described and discussed. The advantages and disadvantages of the crush-dressing process versus the diamond-truing process are discussed, with reference to the physical properties of crystals.

In the discussion E. Flanders points out that the crushing of grinding wheels can best be accomplished by hydraulic rather than other forms of power-feed devices. Aris Phillips, USA

70. A. Michels, S. R. de Groot, and C. A. ten Seldam, "On the shape of backed-off milling cutters" (in English), *Appl. sci. Res. Sec. A*, 1948, vol. 1, no. 3, pp. 219–224.

The geometry of milling cutters is considered. A formula is derived for the relation between the profile, shearing surface, shape of cut, and back-off clearance curve when the last is a spiral and two of the first three are straight or plane.

D. C. Drucker, USA

Hydraulics; Cavitation; Transport

(See also Revs. 78, 126)

71. J. E. Caffyn, "A correction in viscometry due to varying hydrostatic head," *Proc. phys. Soc. Lond.*, Oct. 1948, vol. 61, pp. 367–372.

The Poiseuille equation requires a corrective term to give the volume flow through a capillary tube when the head varies during the time of flow. The author presents a general solution for two bulbs, with shapes which are formed by rotating an arbitrary curve about a vertical axis, in the form of two simultaneous integral equations. He then solves the equations for three special sets of bulbs: cylindrical, biconical and cylindrical with conical ends. The results are presented in a table showing the volume correction for given ratios of change in pressure to applied pressure. V. L. Streeter, USA

72. V. Goutkin, "General method for computing equilibrium chambers with two surge tanks (Méthode générale de calcul des chambres d'équilibre alimentées par 2 canaux d'amenée)," *Houille blanche*, May-June 1948, vol. 3, pp. 246–251.

L. Escande [*Génie civ.*, 1943, Apr. 1 and 15] has already studied the water oscillations in a surge tank with the pressure tunnels discharging out of two reservoir basins, the surface level in both basins being supposed to be the same.

The author generalizes this method of computation for the case when the levels in both reservoirs are different. The equations given by the author can be reduced to the well-known equations for surges solved by the graphic method of Calame and Gaden [Théorie des Chambres d'Équilibre, 1926].

Charles Jaeger, England

73. G. Pattantyus, "Oscillations of water level in surge tanks or break-pressure reservoirs of water power plants" (in English with summary in Hungarian), *Publ. Tech. Univ. Budapest (Müegyetemi Közl.)*, 1947, no. 1, pp. 42–69.

Difficulties are encountered in practical applications, when the damping force is proportional to velocity squared. The author proposes a solution to replace such methods of overcoming these difficulties as: (1) neglecting damping; (2) substituting linear damping; (3) limiting treatment to determination of decreasing amplitudes; and (4) to surge tanks of constant cross section.

The differential equation for the motion of the water surface in the surge tank is simplified, and with a change in variable ultimately takes the form, $u = e^x - x - 1$, which is independent of the dimensions of the system, and may therefore be drawn in advance as a base curve, once and for all.

From this curve the author obtains maximum successive oscillations and intermediate amplitudes. The curve may also represent changes in the acceleration of the water column and loss of head (it is capable graphically of kinematic, dynamic and energetic interpretations). From this curve, a velocity-distance curve is derived, and from it, in turn, a time-space curve. The method is also applied to surge tanks of varying cross section.

M. J. Orbeck, USA

74. R. Barbe, "Measurement of friction coefficient of industrial conduits in the laboratory (La mesure dans un laboratoire des pertes de charge de conduites industrielles)," *Houille blanche*, May-June 1947, vol. 2, pp. 191–203.

Coefficients of friction f for pipe flow as defined by the Darcy equation were determined for high Reynolds numbers varying from 0.50 to 1.50×10^6. Four different types of pipe, each of 800-mm diam and 600 ft long, were tested with joints every 14 to 20 ft. The values of f obtained are compared to the von Kármán-Nikuradse law for smooth pipes and are generally higher, due to the effect of surface roughness.

According to checks by the reviewer, the following values of absolute roughness may be assigned in the generalized Colebrook chart to the pipes tested: bitumastic-coated cast-iron pipe, practically "smooth"; prestressed concrete pipe, 0.00005 ft; welded steel pipe, 0.0001 ft; centrifugally cast concrete pipe, 0.0005 ft. These values are for the most part lower than usually given, probably due to the careful treatment of interior surfaces in the author's experiments. Arthur T. Ippen, USA

75. L. Escande, "Determination of the overpressure created by the closure of a butterfly valve operated by a servomotor (Détermination de la surpression engendrée par la fermeture d'une vanne papillon actionnée par un servo-moteur)," *Génie civ.*, Nov. 15, 1948, vol. 125, pp. 427–430.

The torque acting on a butterfly valve and the discharge of the valve as a function of the opening angle of the valve, have been previously investigated and measured by Gaden [*Schweiz. Bauztg.*, May 21, 28, June 4, 1934].

The author shows that the diagrams given by Gaden can be combined with a graphical water-hammer calculation giving step by step the pressure, the torque, and the discharge as a function of the time, and thereafter the actual closing law of the butterfly valve.

The same problem had previously been solved by analytical methods by E. Meyer-Peter [*Schweiz. Bauztg.*, 1943, vol. 12, nos. 14 and 15]. Charles Jaeger, England

76. André Gardel, "Contribution to the calculation of the hydraulic jump (Contribution au calcul du ressaut hydraulique)," *Bull. tech. Suisse rom.*, Oct. 23, 1948, vol. 74, pp. 269–275.

The problem of the hydraulic jump is encountered in connection with the rational setting of the floor level of a stilling basin in the following form: given the discharge and loss of head, the downstream head for a canal having a determined cross section is to be calculated. Two graphs are plotted by the author, giving, in dimensionless quantities, the downstream head as a function of the loss of head. These graphs treat respectively parabolic cross sections of any given order, and trapezoidal cross sections. The

reference height is a critical depth. The author also gives simple formulas which are practically identical with the graphs when the loss of head is sufficiently large. A. Craya, France

Incompressible Flow: Laminar; Viscous

(See also Revs. 6, 43, 76, 105, 123, 135, 145, 148, 150)

77. **R. S. Rivlin, "The hydrodynamics of non-Newtonian fluids,"** *Proc. roy. Soc. Lond. Ser. A*, May 27, 1948, vol. 193, pp. 260–281.

The general structure of the relation between stress and velocity-strain in an incompressible viscous fluid is established, and two problems of steady laminar flow are discussed, namely the torsional motion of a cylindrical mass of fluid, produced by forces applied to the plane end surfaces of this mass, and the torsional motion of a mass of fluid between infinite coaxial cylinders rotating with different angular velocities about their common axis. W. Prager, USA

78. **C. L. Pekeris, "Stability of the laminar flow through a straight pipe of circular cross section to infinitesimal disturbances which are symmetrical about the axis of the pipe,"** *Proc. nat. Acad. Sci. Wash.*, June, 1948, vol. 34, pp. 285–295.

The author shows that the laminar flow through a pipe of circular cross section is stable with respect to axially symmetric disturbances. Stability with respect to disturbances of the torsional type has been shown by Synge. "The stability to meridional perturbations was studied by Sexl, but his treatment is shown to be incomplete. In this investigation, an explicit expression is derived for the characteristic value in the case of a meridional disturbance which is valid for small Reynolds numbers. An asymptotic expression for the (characteristic value) C, valid for large (Reynolds numbers) R, is also derived." Further details are given, which make the investigation very thorough.

Courtesy of Mathematical Reviews C. C. Lin, USA

Compressible Flow, Gas Dynamics

(See also Revs. 78, 98, 99, 109, 111, 113, 122)

79. **G. M. Roper, "The flat delta wing at incidence, at supersonic speeds, when the leading edges lie outside the Mach cone of the vertex,"** *Quart. J. Mech. appl. Math.*, Sept. 1948, vol. 1, pp. 327–343.

The linearized solution for the surface pressures on a flat plate of triangular planform are obtained for the case where the leading edges are supersonic (swept ahead of the Mach cone). The method of analysis is analogous to that used by W. D. Hayes and P. A. Lagerstrom [*Nat. adv. Comm. Aero. tech. Note*, no. 1685]. E. V. Laitone, USA

80. **T. Y. Thomas, "On the stability and instability of shock waves,"** *Proc. nat. Acad. Sci. Wash.*, Nov. 1948, vol. 34, pp. 526–530.

From certain relationships between an attached shock and the body curvatures at the vertex of the body, as well as between the higher derivatives of the curvatures, the author obtains the result that an "instability" of the nose shock generally occurs when the Mach number behind the shock is equal to or less than one.

The reviewer remarks that similar statements were made by Crocco ["Singolarita della corrente gassosa iperacustica nell' in torno di una prora a diedro," *Aerotecnica*, 1937, vol. 17], and it was shown by Guderley ["Considerations on the structure of mixed subsonic-supersonic flow patterns," *Hdqtrs. Air Mat. Comm. Dayton tech. Rep.*, no. F-TR-2168-ND] that Crocco's conclusions were in error. The difficulties encountered are probably due to the author's assumption that the shape of the shock can be represented by an analytic function; furthermore, the author's definition of "local stability" need not necessarily mean true physical instability. Hideo Yoshihara, USA

81. **P. Neményi and R. Prim, "Some geometric properties of plane gas flow,"** *J. Math. Phys.*, July 1948, vol. 27, pp. 130–135.

The authors essentially answer the following question on two-dimensional steady flows of a perfect fluid in the absence of external forces: What forms of streamlines are possible if the velocity magnitude or the vorticity of the flow along each of them is constant? The results can be summarized as follows: The lines of constant vorticity coincide with the lines of constant velocity magnitude only if they are streamlines. Constant vorticity along each streamline implies constant speed along the same lines; this case is possible only if all streamlines are parallel straight lines or concentric circles. S. S. Shu, USA

82. **R. C. Roberts, "Note on the lift of a triangular wing at supersonic speeds,"** *J. Math. Phys.*, Apr. 1948, vol. 27, pp. 49–55.

A formula for the lift on a delta wing moving with supersonic speeds was found by H. J. Stewart [*Quart. appl. Math.*, 1946, pp. 246–254] based on the linearized theory and the concept of conical flow as first suggested by A. Busemann. The present author determines the lift of a wing of any triangular planform provided it lies entirely within the Mach cone. S. S. Shu, USA

83. **R. C. Prim, "On a family of rotational gas flows,"** *Quart. appl. Math.* Oct. 1948, vol. 6, pp. 319–325.

The paper presents a formally simple infinite family of rotational compressible flows of an ideal gas.

Figures are included showing the flow patterns for air at four different limiting angles. Nicholas Di Pinto, USA

84. **E. Carafoli, "High-velocity aerodynamic profiles (Profile aerodinamice de mare viteza),"** *Studii*, Jan.-Mar. 1948, no. 1, pp. 11–20.

For high subsonic velocities, experience has shown that special turbulence phenomena and supersonic speeds appear in different parts of the wing sections, which require the development of special "laminar profiles" for airplane wings.

The present paper deals with the application, to this special case, of a general method for designing wing sections, proposed in 1928 by Toussaint and the author.

According to the author, the most important parameter of the wing profile is the position of maximum thickness, and indications are given how to apply the author's method to the determination of this parameter. Applications for simple laminar and wedge laminar profiles as well as two numerical examples are given. Aurel A. Beleş, Rumania

85. **Maurice Roy, "Nozzles, mixing chambers, and jets (Tuyères a gaz, mélangeurs et jets),"** *Rech. aéro. Paris*, July 1948, no. 4, pp. 5–9.

This paper deals with the adiabatic flow of an ideal gas in a duct or a free jet having nonuniform energy distribution at the entrance section. The flow is described in a one-dimensional

manner in terms of mean values of the characteristic properties of the moving gas. Relations among these mean values are established, using the concept of adiabatic efficiency and of a "coefficient of irregularity" (ratio of mean velocity to the root mean square of the velocity). In addition the author suggests that a systematic research program on mixing phenomena in ducts, based on the above concepts, be carried out.

Andrew Fejer, USA

86. S. V. Falkovich, "Lift force of a wing of finite span" (in Russian), *Appl. Math. Mech. (Prikl. Mat. Mekh.)*, Jan.-Feb. 1947, vol. 11, pp. 171–176.

The linearized supersonic flow equations corresponding to a trapezoidal flat plate at small angles of attack are solved by the application of acceleration potential (which somewhat simplifies the basic integral equation). Schlichting's error [*Nat. adv. Comm. Aero. tech. Memo.* no. 897] at the tips of the plate is rediscovered.

M. V. Morkovin, USA

87. R. C. Prim, "On the existence of steady gas flow in plane isothermal streamline patterns," *Bull. Amer. math. Soc.* Oct. 1948, vol. 54, pp. 1009–1012.

The author examines the possibility of steady planar flows of an ideal (that is inviscid, thermally nonconducting) gas having streamlines which can be mapped conformally onto a family of parallel lines. No restriction is placed upon the rotationality of the flow. It is found that the only streamline patterns which satisfy the required condition consist of concentric circles, radial straight lines, or parallel straight lines. [The word "isothermal" is used in its geometric sense: $u(x, y) = C$ is the equation of an "isothermal" family when u is a harmonic function.]

Walter Vincenti, USA

88. Hsu Lo, "Determination of transient skin temperature of conical bodies during short-time high-speed flight," *Nat. Adv. Comm. Aero. tech. Note*, no. 1725, Oct. 1948, pp. 1–42.

The determination of the transient skin temperature of conical bodies during short-time high-speed flight is accomplished by means of a short and simple method. A differential equation for taking into account aerodynamic heating and body radiation is presented for the calculation of the skin temperature for any prescribed flight history. A simplified differential equation which neglects body radiation is also given and may be used in many cases, saving both time and labor. For the heat-transfer coefficient and boundary-layer temperature which are needed in the differential equation, Eber's experimental results for conical bodies under supersonic conditions are adapted and summarized in a convenient way.

The method is applied first to flight at constant altitude, and then to arbitrary flight. The calculated skin temperature for a V-2 missile is in good agreement with the measured data. The effects of heat-absorption capacity of the skin are discussed. The paper clearly defines the limitations of the proposed method of calculation for flights at extremely high altitudes.

H. E. Sheets, USA

89. A. W. Morley, "The efficiency of adiabatic expansion," *Coll. Aero. Cranfield Rep.*, no. 21, Sept. 1948, pp. 1–13.

The efficiency of an adiabatic expansion is characterized in this study by the so-called polytropic efficiency. By means of this value the polytropic exponent can be calculated, and thus a definite relation between pressure and temperature (or pressure and density) during the expansion established. By combining this equation with the corresponding equations for mass flow and energy for the one-dimensional flow through a nozzle, a subsonic velocity is obtained in the critical section.

However, experiments and more detailed theoretical considerations show that a Mach number of 1 is reached in the critical section, so that the critical mass flow is not accurately obtained by the above method. Of course the proper approach to the problem would be a two-dimensional calculation.

A simpler approximate method is given by the author, and consists in calculating the temperature in the critical section by means of the assumption that the Mach number there is equal to 1. The density and pressure corresponding to the velocity of sound are then calculated from the polytropic equation. The "choking" mass flow is given by these values.

E. Haenni, USA

90. B. Cassen and J. Stanton, "The decay of shock waves," *J. appl. Phys.*, Sept. 1948, vol. 19, pp. 803–807.

The instantaneous rate of decay or intensification of a shock front is shown to be directly related to the pressure gradient in the wake of the wave at the shock front. The analysis is based upon the Lagrangian form of the equations of hydrodynamics. The entropy transport equation requires that energy dissipation be localized at the shock front. The higher time derivatives of the shock velocity are also related to higher spatial derivatives of the pressure at the shock front. The general theory is applicable to shocks of any strength in fluids for which adequate state data exist. An experimental instance is discussed of an intense shock with strong spherical divergence which maintained constant velocity for several hundred microseconds.

Stuart R. Brinkley, Jr., USA

91. F. E. Ehlers, "Methods of linearization in compressible flow. Part I—Janzen-Rayleigh method," *Hdqtrs. Air Mat. Comm. Dayton Tech. Rep.*, no. F-TR-1180A-ND, Feb. 1948, pp. 1–101.

This is a good expository monograph covering the theory and results of the Janzen-Rayleigh method in subsonic compressible flow. This method consists of expanding the solution for the flow about an obstacle in a power series in M^2, where M is the Mach number of the uniform flow at infinity.

The monograph includes the work of Poggi, Kaplan, Imai, and many others. The major part of the work deals with two-dimensional flow, with the flow about circular and elliptic cylinders, Rankine ovals, and Joukowsky airfoils in restricted or free streams. Spheres and ellipsoids of revolution are treated.

If such reports as this one were assured adequate distribution they would go far toward relieving the present space shortage in technical journals.

Wallace D. Hayes, USA

92. A. W. Morley, "Note on the efficiency of adiabatic shock," *Coll. Aero. Cranfield Rep.*, no. 22, Sept. 1948, pp. 1–10.

Efficiency of compression, pressure ratio, and upstream and downstream Mach numbers at a shock wave are calculated and plotted as functions of Mach angle and angle of fluid deflection. The efficiency is defined as the ratio of isentropic to actual work (change of enthalpy) for a compression from upstream static pressure and temperature to downstream total pressure. For the actual nonisentropic process the basic equations are those expressing constancy of energy, equilibrium of forces, continuity of flow, and constancy of tangential velocity component.

Until the initial Mach number reaches 1.8, a maximum efficiency of nearly 100 per cent can be obtained with oblique shocks

(small deflection angles), but at higher velocities the efficiency drops rapidly. For a given initial Mach number, a higher efficiency can always be obtained with an oblique than with a normal shock, although the pressure ratio will be less. However, if the initial Mach number is sufficiently high with the oblique shock, the same pressure ratio can be obtained with higher efficiency than with the normal shock.

C. W. Smith, USA

93. **Howard W. Emmons, "Flow of a compressible fluid past a symmetrical airfoil in a wind tunnel and in free air,"** *Nat. adv. Comm. Aero. tech. Note*, no. 1746, Nov. 1948, pp. 1–31.

The effects of compressibility on the flow about an NACA 0012 airfoil in a wind tunnel and in free air are investigated by the relaxation method. The details of the procedure were given in a previous paper by the author [*Nat. adv. Comm. Aero. tech. Note*, no. 932, 1944]. The solutions obtained cover cases of incompressible, and both subsonic and supersonic flows, as well as cases in which the supersonic region terminates with a shock wave. The calculations are too lengthy to be used for a wide range of examples without the use of high-speed calculating machines. It is found that the results of this theory agree better with experimental data than approximate formulas such as are given by the Prandtl-Glauert or the von Kármán-Tsien theories.

The pressure coefficients and Mach number variations along the airfoil in a wind tunnel and free air were greater than experimentally determined because the boundary layer was neglected in the calculations.

It is found that, because of the requirement of continuity of streamline curvature across the shock at the airfoil surface, the discontinuous drop of pressure coefficient through the shock is followed by a rapid rise. Thus the experimental fact that the measured value of this drop is never as large as would be expected from the Mach number before the shock may be accounted for.

Bruno A. Boley, USA

94. **John W. Miles, "Transient loading of airfoils at supersonic speeds,"** *J. aero. Sci.*, Oct. 1948, vol. 15, pp. 592–598.

In this paper the author has developed expressions for the variation with time of lift and moment coefficients of two-dimensional airfoils at supersonic speeds, for various nonsteady-state conditions. Using the results for the pressure distribution over a supersonic airfoil due to a harmonic velocity distribution, and the Fourier integrals for step and impulse functions, the pressure distribution and lift and moment coefficients have been calculated for the uniform entry of a flat plate into a sharp-edged gust and for the sudden deflection of a flap, the latter including the sudden pitching of the entire airfoil as a special case. Results are given in the form of algebraic equations and curves for C_L and C_M for $M = 1, 2, 2^{1/2}, 4$, and ∞.

The various conditions are compared with each other and, qualitatively, with the subsonic case. It is pointed out that the incompressible case differs markedly from the supersonic problem because of the influence of wake in the subsonic case. Methods are also recommended for calculating the effects of gusts which are not sharp-edged and uniform, for the supersonic case.

The results are particularly useful because the author has reduced them to practical engineering expressions.

E. Arthur Bonney, USA

95. **Pierre Richard, "A graphical determination of the flow in nozzles,"** *Aircr. Engng.*, Oct. 1948, vol. 20, pp. 293–296, 314.

Nomograms for solving the scalar problems in one-dimensional, adiabatic, frictionless nozzle flow are developed. It is also shown how the location of a normal shock in the nozzle may be found graphically when the nozzle is not "tuned" to the pressure in the exhaust region.

Ascher H. Shapiro, USA

96. **Sidney M. Harmon, "Stability derivatives of thin rectangular wings at supersonic speeds—wing diagonals ahead of tip Mach lines,"** *Nat. adv. Comm. Aero. tech. Note*, no. 1706, Nov. 1948, pp. 1–33.

Theoretical results are obtained, by means of linearized theory, for the pressure distributions and stability derivatives for various motions at supersonic speeds of thin flat rectangular wings without dihedral. The investigation includes steady and accelerated vertical and longitudinal motions, and steady rolling, yawing, sideslipping and pitching, for Mach numbers and aspect ratios greater than those for which the Mach line from the leading edge of the tip section intersects the trailing edge of the opposite tip section.

From considerations of the boundary layer, the author concludes that the Kutta condition should not be satisfied at the trailing side edge of a yawed wing if the angle of yaw is small. With this the reviewer is in agreement. A contemporary treatment by A. L. Jones, J. R. Spreiter, and A. Alksne [*Nat. adv. Comm. Aero. tech. Note*, no. 1700] employs the opposite view. Application of the Kutta condition markedly alters the sideslip derivatives.

A significant finding of this paper relates to the so-called "single-degree-of-freedom torsional oscillation" that has been predicted by Garrick and Rubinow [*Nat. adv. Comm. Aero. Rep.* no. 846] and others for the wing of infinite aspect ratio. The unstable tendency is decreased for finite wings and disappears below a certain aspect ratio.

Herbert S. Ribner, USA

97. **Clinton E. Brown, "Theoretical lift and drag of thin triangular wings at supersonic speeds,"** *Nat. adv. Comm. Aero. tech. Note*, No. 1183, Dec. 1946 (issued in 1947), pp. 1–26.

A method is derived for calculating the lift and the drag due to lift of point-forward supersonic triangular wings with both subsonic and supersonic leading edges. [See also H. J. Stewart, "The lift of a delta wing at supersonic speeds," *Quart. appl. Math.*, Oct. 1946, vol. 4, no. 3.] Since the results of the analysis have by now been obtained by numerous investigators the principal point of interest lies in the fact that this is perhaps the first published solution employing methods different from formal conical-flow theory to treat wings with subsonic leading edges.

Max A. Heaslet, USA

Turbulence, Boundary Layer, etc.

(See also Revs. 78, 146)

98. **Maurice Roy, "On propulsion with restitution of the boundary layer (Sur la propulsion par régénération de la couche-limite),"** *C. R. Acad. Sci. Paris*, Nov. 8, 1948, vol. 227, pp. 940–943.

It is shown in this paper that the power required for the propulsion of a solid body through a fluid is not necessarily reduced by an appreciable amount by boundary-layer control. In the example studied in the paper the boundary-layer particles removed are restituted into the wake of the body with a relative velocity equal but opposite to the forward velocity of the body. Of course, the body would have no drag in this case, but a certain power would be required to remove the boundary layer and expel it into the wake.

By means of general impulse and energy equations it is shown

that both the propulsive power without boundary-layer restitution, and the power required for the restitution are equal to the total power absorbed by friction in the fluid. In the case of boundary-layer restitution the power absorbed in the boundary layer around the body will be smaller than without boundary-layer control, especially if the boundary layer can be kept in the state of laminar flow. On the other hand new boundary layers are introduced due to the suction channels and the suction mechanisms, so that the gains in power might not be as considerable as sometimes expected.

The reviewer notes that the present example considers the use of additional mechanisms for boundary-layer suction. If the normal propulsive mechanisms are used for this purpose the picture might look better, especially in the case of gas-turbine engines where the energy of the jet could probably be effectively used for the suction. E. Haenni, USA

99. Vernon Outman and Arthur A. Lambert, "Transonic separation," *J. aero. Sci.*, Nov. 1948, vol. 15, pp. 671–674.

Rudimentary considerations combined with flight and wind-tunnel tests suggest to the authors the introduction of the angle between the aft surface of an airfoil and the line of flight as an index of the Mach number at which airflow separation will occur. This criterion may be useful for preliminary design purposes, but the reviewer does not believe that this single parameter is sufficient to cover all cases. Walter Wuest, Germany

100. S. D. Nigam, "On development of turbulent liquid motion over an infinite plate," *Phil. Mag.*, Nov. 1948, vol. 39, pp. 867–873.

A mathematical solution of the problem of spread of a two-dimensional turbulent motion perpendicular to a very large plate is presented, using a variant of Taylor's vorticity transfer theory. Hugh L. Dryden, USA

Aerodynamics of Flight; Wind Forces

(See also Revs. 10, 79, 82, 84, 86, 88, 94, 96, 97, 98, 99, 113, 115, 118, 123, 151)

101. Margaret F. Steiner, "Analysis of planing data for use in predicting hydrodynamic impact loads," *Nat. adv. Comm. Aero. tech. Note*, no. 1694, Aug. 1948, pp. 1–36.

An analysis is made of planing data covering a wide range of dead-rise angles, trims, speeds and beam loadings. The analysis is divided into three phases in which the inertia force is determined by evaluating: (1) data from tests in which the chines are above level water and the buoyant force is negligible; (2) data from tests in which the chines are above level water and the buoyant force is significant; and (3) data in which the chines are immersed, with buoyant and steady-flow forces included.

The planing coefficients and gravity correction factors which are included in the resultant equations may be substituted directly in the general hydrodynamic impact-load equations for angles of dead rise between 10 and 30 deg if the buoyant and steady-flow forces are also used, and if the effect of gravity at different Froude numbers is assumed to be independent of the accelerations which occur during impact. Ernest G. Stout, USA

102. F. Weinig, "Lift and drag of wings with small span," *Nat. adv. Comm. Aero. tech. Memo.*, no. 1151, Aug. 1947, pp. 1–13 (transl. from *Dtsch. Luftfahrtforsch. Forschungsber.*, no. 1665).

The author, starting with an expression for the mass of air deflected downward per unit time by a wing of elliptic planform, derives expressions for the lift coefficient and induced-drag coefficient that are somewhat different from the conventional formulas based on Prandtl's theory.

The difference in the values of the coefficient computed by the existing and by the modified theory becomes greater as the angle of attack increases and as the aspect ratio of the wing decreases, especially when it becomes less than two.

Since the agreement between the modified theory and the wind-tunnel tests is good, the theory presented in this paper should be of interest to anyone engaged in aerodynamic design of tail surfaces. A. Petroff, USA

103. Harry C. Mickleboro, "Evaluation of a fixed spoiler as a gust alleviator," *Nat. adv. Comm. Aero. tech. Note*, no. 1753, Nov. 1948, pp. 1–14.

Wind-tunnel tests of upper surface spoilers indicate a reduced lift-curve slope, which, if present for transient conditions, would provide as much as 65 per cent alleviation of gust accelerations on an airplane so equipped. Gust-tunnel tests of an airplane model indicated no reduction in a sharp-edged gust and a reduction of 30 per cent in a gust with a gradient distance of 12 chords. Philip Donely, USA

104. M. I. Haar, "Tank tests of a 1/10-size model of a hypothetical flying boat with a hull length-beam ratio of 9.0," *Nat. adv. Comm. Aero. tech. Note*, no. 1648, July 1948, pp. 1–47.

In selecting the over-all proportions for a flying-boat hull, the effect of length-beam ratio on the aerodynamic and the hydrodynamic characteristics is of primary importance. Tests conducted on a powered dynamic model indicate that increasing the hull length-beam ratio from 6 to 9, while holding the product of the square of the length by the beam constant, introduces no serious adverse hydrodynamic characteristics, and such a product may be used by the designer as a size factor for determining hull proportion for a given design.

The effects of gross load, depth of step, angle of afterbody keel, and length of afterbody are shown to be approximately the same for the higher length-beam ratio as for conventional length-beam ratios. The use of a high length-beam ratio results in an appreciable reduction in aerodynamic drag. Ernest G. Stout, USA

105. R. M. Conard, "Effect of sweptback shape on airfoils (L'effet de flèche appliquée aux aérodynes)," *Rech. aéro. Paris*, May, 1948, no. 3, pp. 5–27.

This first part of a treatment of sweptback wings deals with incompressible flow. The remaining parts are to include high-velocity aerodynamics and aeroelasticity. The point of view is that of a practicing aerodynamicist.

After a detailed discussion of the aerodynamic behavior of swept wings, the author discusses the application of high-lift devices, and presents a list of pending problems accompanied by an associated program of research. Wallace D. Hayes, USA

106. Robert G. Mungall, "Flight investigation of a combined geared unbalancing-tab and servotab control system as used with an all-movable horizontal tail," *Nat. adv. Comm. Aero. tech. Note*, no. 1763, Dec. 1948, pp. 1–16.

By means of a linkage incorporating a viscous damper, a servotab system was modified to obtain a combined geared unbalancing-tab and servotab control system. For slow stick deflections, the damper allowed the tabs to operate as servotabs. For rapid stick deflections, however, the viscous damper acted as a rigid

link, and provided geared unbalancing-tab characteristics. Flight tests of this system installed on an all-movable horizontal tail surface showed a general improvement in control characteristics over tab and bobweight arrangements previously tested; but defects, presumably due to the linkage system and static friction in the viscous damper, were still apparent.

Arthur L. Jones, USA

107. **G. Lange, "Force- and pressure-distribution measurements on eight fuselages,"** *Nat. adv. Comm. Aero. tech. Memo.*, no. 1194, Oct. 1948, pp. 1–35 (transl. from *Zent. wiss. Berichtswesen Berlin Forschungsber.*, no. 1516, Oct. 1941).

Force- and pressure-distribution measurements are reported for a number of fuselage forms with thickness ratios of 10, 17.5 and 25 per cent, maximum thicknesses located at 30, 40 and 50 per cent, and nose radii of 1, 2 and 3 times "normal." The fuselages were designed as bodies of revolution. Results are presented in charts which facilitate the study of effects of variation of geometric parameters upon lift, drag and pitching moment at various angles of attack and yaw. Pressure-distribution data show good agreement with theory at low angles of attack but not at high angles of attack where potential flow could not be assumed.

John E. Goldberg, USA

108. **M. J. Queijo and Byron M. Jaquet, "Calculated effects of geometric dihedral on the low-speed rolling derivatives of swept wings,"** *Nat. adv. Comm. Aero. tech. Note*, no. 1732, Oct. 1948, pp. 1–21.

The analysis presented in this paper is for a swept wing in rolling flight at low speeds. It is based upon the conventional strip theory and the assumption that dihedral effects on aerodynamic induction can be neglected. It appears that the damping-in roll and the lateral force due to roll are significantly influenced by geometric dihedral, but that the yawing moment due to roll is almost independent of dihedral. The results presented are satisfactory for taper ratios as low as 0.5.

A wind-tunnel investigation at Mach number 0.13 on a 45-deg untapered swept wing having an aspect ratio of 2.61 and dihedral angles from 10 deg to −20 deg yielded results which checked the theory satisfactorily.

Dana Young, USA

109. **W. E. Moeckel and J. C. Evvard, "Load distributions due to steady roll and pitch for thin wings at supersonic speeds,"** *Nat. adv. Comm. Aero. tech. Note*. no. 1689, Aug. 1948, pp.1–28.

A method is presented for determining the load distribution due to steady roll and steady pitch on thin wings whose planform is arbitrary except that a part of the leading edge must be supersonic. When the supersonic part of the leading edge is a straight line, these load distributions can be explicitly evaluated for all regions of the wing except those influenced by interacting flow fields off the planform.

For a particular family of wings having a planform that includes most types of flow field commonly encountered, the load distributions due to angle of attack, steady roll, and steady pitch are computed. The lift distribution for the family of wings investigated shows that negative lift may exist toward the rear of pointed wings if the aspect ratio is small. The highest lift occurs in regions affected only by leading edges. In steady roll, negative loading occurs in regions influenced by the edge of the planform at the opposite side of the roll axis. At the extreme rear of a low-aspect-ratio wing, the loading again becomes positive. With the pitch axis located near the semichord position, the load gradient for steady pitch is primarily in the chordwise direction except in regions influenced by subsonic trailing edges. High positive loading occurs toward the front of the wing and high negative loading toward the rear.

E. Arthur Bonney, USA

110. **Daniel Savitsky, "Theoretical and experimental wing-tip accelerations of a small flying boat during landing impacts,"** *Nat. adv. Comm. Aero. tech. Note*, no. 1690, Sept. 1948, pp. 1–34.

The simplified method presented for predicting the history of acceleration along the wing of a seaplane during landing impact requires knowledge of the space function defining the wing shape in the particular mode of vibration, the mass distribution along the wing, and the history of the hydrodynamic impact force. Evaluation of the transient oscillatory component of acceleration for any point on the wing for a particular bending mode is reduced to the solution of the differential equations for an equivalent single-mass oscillator. Expressing the impact forcing function by a simple mathematical curve yields a simple solution.

Using the wing shape for the first bending mode obtained from ground forced-vibrations tests, and the force-time curve for the hydrodynamic impact (approximated as a sine curve) obtained from hull accelerations, computed wing-tip accelerations are found to agree well with the measured ones for a small amphibian in which only the fundamental wing bending mode was important.

J. M. Robertson, USA

111. **W. A. Tucker, "Characteristics of thin triangular wings with constant-chord full-span control surfaces at supersonic speeds,"** *Nat. adv. Comm. Aero. tech. Note*, no. 1601, July 1948, pp. 1–25.

A theoretical analysis of the characteristics of constant chord full-span control surfaces on thin triangular wings at supersonic speeds was made by use of the linearized supersonic flow theory. Expressions were found for the lift, pitching moment, hinge moment due to control deflection, and hinge moment due to angle of attack. The calculations cover the entire range of control surface chords, wing apex angles, and Mach numbers for which the flow around each control surface tip is independent of the other control surface tip.

H. J. Stewart, USA

Aeroelasticity (Flutter, Divergence, etc.)

(See also Revs. 99, 116, 134)

112. **Roger A. Anderson and John C. Houbolt, "Determination of coupled and uncoupled modes and frequencies of natural vibration of swept and unswept wings from uniform cantilever modes,"** *Nat. adv. Comm. Aero. tech. Note*, no. 1747, Nov. 1948, pp. 1–42.

The deflection and twist of the nonuniform swept wing are expanded in terms of the natural modes of a uniform cantilever and three additional terms for the pitching and rolling angles and displacement of the rigid fuselage. The coefficients of the normal modes are taken as the generalized co-ordinates. Fuselage displacements are related to the sweep angle and the slope and twist at the wing root by geometric boundary conditions which, together with the dynamic boundary conditions, establish the type of vibration as symmetric or antisymmetric. The difference in the maximum kinetic and potential energies is minimized with respect to the generalized co-ordinates to establish the natural frequencies of the airplane.

Since the coupled natural modes of the nonuniform swept wing correspond closely with one of the uniform cantilever modes used in the expansion, accurate determination of the natural frequencies is possible from a low-order determinant without the use of a large number of significant figures. The method and accuracy are

illustrated and compared with known exact solutions for a free-free uniform beam and an airplane having a uniform wing with 45-deg sweep angle. W. T. Thomson, USA

113. Warren A. Tucker and Robert L. Nelson, "The flexible rectangular wing in roll at supersonic flight speeds," *Nat. adv. Comm. Aero. tech. Note*, no. 1769, Dec. 1948, p. 1–42.

Owing to the flexibility of the wing structure, the wing will be twisted by the torsional moment introduced through the deflected ailerons. The present paper treats the loss in rolling effectiveness of the rectangular wing with constant chord ailerons extending inboard from the wing tips. The aerodynamic load is calculated with linearized theory of the supersonic flow.

In the analysis, some simple reasonable assumptions are made: (*a*) the twisting moment about the middle of the chord is due only to the aileron deflection; (*b*) no twist of the aileron itself is considered; (*c*) the wing torsional stiffness is considered to vary with the distance from the center of the span (1) linearly, or (2) cubically.

Under such given conditions, explicit expressions are obtained for both the loss in rate of roll due to flexibility, or the torsional stiffness required to maintain a given rate of roll. Some computation formulas and graphs are given so that calculations can be made without reference to the details of the analysis.

Chieh-Chien Chang, USA

114. W. J. Duncan, "Flutter of systems with many freedoms," *Coll. Aero. Cranfield Rep.*, no. 19, Aug. 1948, pp. 1–19.

This paper is divided into two parts. In Part I there are discussed two criteria, which may be used to determine whether or not a particular additional degree of freedom F will have an appreciable effect on the flutter speed calculated without F considered, and, therefore, whether or not a complete analysis with F included should be made. Both criteria are based on an energy balance which is expressed in terms of an integral of the dissipation function over one cycle at the previously calculated flutter frequency. The simplest criterion requires that the amplitude of F be small, an assumption which is checked a posteriori.

In Part II various methods of determining the flutter speed and frequency in systems with a large number of degrees of freedom are considered. The orthodox method of solution, involving the expansion of a complex determinant into two polynomials, is not considered by the author to be efficient when the number of degrees of freedom is greater than three. Several inverse methods of solution are discussed briefly. Paul A. Libby, USA

Propellers, Fans, Turbines, Pumps, etc.

(See also Rev. 95)

115. Herbert S. Ribner, "Formulas for propellers in yaw and charts of the side-force derivative," *Nat. adv. Comm. Aero. Rep.*, no. 819, 1945 (issued in 1948), pp. 1–12.

In this report, formulas are given for the rate of change of propeller side force and the rate of change of propeller pitching-moment coefficient with angle of yaw. These formulas are then used in the preparation of charts which give the side-force derivative as a function of the advance-diameter ratio for two typical propellers, namely the Hamilton Standard 3155-6 and the NACA 10-3062-045.

Solidity and blade angle are the parameters, and both single and dual rotation are considered. Agreement of the equations and charts with experiment is good over a wide operating range.

A physical interpretation of the production of side force by a propeller in yaw is given. The propeller may be represented as a fin, with effective aspect ratio about eight, with an area equal to the projected side area of the propeller, and with a dynamic pressure approximately equal to that at the propeller disk, appropriately increased by the inflow effect.

Frank L. Wattendorf, USA

116. G. A. Dirac, "The vibration of propeller blades," *Aircr. Engng.*, Nov. 1948, vol. 20, pp. 322–329, 343.

The torsional and flexural vibrations of a propeller blade of arbitrary construction are discussed. The equations of motion are derived in integrodifferential form and are solved by the use of power-series approximations. The treatment is cumbersome and does not add to present knowledge of the subject.

Martin Goland, USA

117. E. S. Bishop, "Dynamic analysis of high-speed compressor valves," *Refrig. Engng.*, Dec. 1948, vol. 56, pp. 503–507.

This paper considers the time variation of pressure in the cylinder of a high-speed reciprocating gas compressor as affected by inertia of the discharge valve and of the gas itself. A method for roughly estimating the inertia effects is shown to be in qualitative agreement with test results for a specific machine.

John V. Becker, USA

118. R. C. Pankhurst, J. N. Veasey, J. R. Greening, and E. M. Love, "Tests of contrarotating propellers of 2⅞-ft diam at positive pitch on a Typhoon aircraft model," *Rep. Memo. aero. Res. Comm. Lond.*, no. 2216, Oct. 1945 (issued in 1948), pp. 1–38.

Extensive thrust and torque measurements have been made on small propellers attached to an airplane model to determine the effect of pitch and other variables on single and counterrotating propellers and, in the case of bolted-together propellers, the effect of angular stagger. Results indicate that the propulsive efficiency of counterrotating propellers is generally smaller than that of each of its component propellers alone, and smaller than that of a bolted-together propeller, probably because the area of turbulent flow over the wing behind the propeller is also smaller with single propellers, and the airplane drag correspondingly smaller.

John E. Goldberg, USA

119. Hunt Davis, "A method of correlating axial-flow-compressor cascade data," *Trans. Amer. Soc. mech. Engrs.*, Nov. 1948, vol. 70, pp. 951–955.

An empirical method is presented for correlating wind-tunnel tests on airfoil cascades in terms of the camber, solidity and stagger of the cascade, and the entrance angle and turning angle of the flow. Given any four of these parameters, the fifth may be determined by means of two charts. The method of constructing such charts is given, and a sample set, made from tests on about 40 different cascades having airfoils of the NACA four-digit series, is presented. The profile drag cannot be determined from these charts. J. M. Wild, USA

Flow and Flight Test Techniques

(See also Revs. 93, 119)

120. Edmond Brun and Max Plan, "On the measurement of temperature of gas streams with high speeds (Sur la mesure de la température des courants gazeux rapides)," *C. R. Acad. Sci. Paris*, Oct. 11, 1948, vol. 227, pp. 714–715.

The authors discuss the optimum rates of ventilation of high-velocity temperature probes. They point out the deviation such probes might give in the case of flow where condensation shocks do take place at the probe. They report some experimental results to substantiate the validity of the analytical relations they present.

Y. S. Touloukian, USA

121. **W. J. Clark, "An electromagnetic indicating or recording remote-reading rotameter,"** *J. sci. Instrum.*, Aug. 1948, vol. 25, pp. 257–262.

The paper reports of the further development of the familiar rotameter whose essential part is a self-adjusting resisting body in a taper tube. It serves for flow measurement of liquids and gases. After dealing with the advantages and disadvantages of the usual direct-reading indication, a superior method of electromagnetic indication is described. Owing to ingenious design, it allows the use of a very short metallic taper tube, and leads to a compact instrument, easy to operate.

The paper gives pictures of the new device and calibration curves of the dependence of the float position (expressed in μA) on the rate of flow for the various types of design. The errors due to variations in temperature and electric resistance are negligible according to the author. Records taken over many days showed good consistency and steady calibration. The instrument may be used up to pressures of 350 atm and for pulsating flows.

Otto Conrad, Germany

122. **P. L. Chambré and S. A. Schaaf, "The theory of the impact tube at low pressures,"** *J. aero. Sci.*, Dec. 1948, vol. 15, pp. 735–737.

It is shown that the Rayleigh formula for the determination of the Mach number from the ratio of impact to static pressure leads to large errors when the stream pressure is so low that the mean free path is larger than the impact tube diameter. Assuming free molecular flow, diffuse reflection, steady state and Maxwellian equilibrium, neglecting all outgassing phenomena and excluding disturbances in the gas stream, the authors derive the formula:

$$k = \{bW(L/br) - 0.5(b-1)[(L/br)^2 + 2 - (L/br)(4 + L^2/b^2r^2)^{1/2}]\} \times \{e^{-s^2} + s\pi^{1/2}[1 + \mathrm{erf}(s)]\}/(WL/r),$$

where k is the ratio of the product of pressure and density in the measuring device (which is located at the end of the impact tube) to that in the free stream, s is the ratio of the macroscopic stream velocity to the most probable molecular speed in the free stream, WL/r is the probability of a reservoir molecule escaping through a tube of length-to-radius ratio L/r, erf is the error function, and $b = 1 + s$.

The results differ very considerably from the corresponding continuum relations. In particular, the ratio k is found to increase with the length-to-radius ratio of the impact tube—a geometric parameter which does not appear in the Rayleigh formula.

Joseph V. Foa, USA

123. **S. Katzoff and Margery E. Hannah, "Calculation of tunnel-induced up-wash velocities for swept and yawed wings,"** *Nat. adv. Comm. Aero. tech. Note*, no. 1748, Nov. 1948, pp. 1–26.

The method presented in this report has the distinct advantage that only one chart need be prepared for a given rectangular tunnel, since this chart, along with one presented in the report, can be used to obtain tunnel-induced up-wash velocities for any span loading and wing geometry. The methods in general use at present entail calculations for wings of various spans and sweep angles.

It is shown that the image system for a point element of lift located anywhere in a horizontal plane of symmetry of a rectangular closed-throat tunnel can be represented by two superimposed, doubly infinite, $2b$ by h rectangular arrays of doublet lines (b is tunnel width, h tunnel height). These two arrays are dependent only on tunnel dimensions, and differ only in that they are displaced with respect to one another and that the doublet representing the point element of the lift must be omitted from one. The same chart can be used to represent the induced field for each array if a second chart is prepared to eliminate the effect of the doublet representing the model. By properly locating the charts over a plan view of the wing in the tunnel, values can be read off which, when summed, provide the induced up-wash.

This method is shown to be applicable to rectangular tunnels of various wall configurations by setting up the proper array of line doublets. Effective adaptation to a circular tunnel can be made; however, in this case a series of charts must be constructed for a series of spanwise locations of the doublet in the tunnel. Example charts for the Langley full-scale tunnel, two-dimensional tunnels (3×7.5 ft), and 7×10 ft tunnels, are given.

Henry H. Hoadley, USA

124. **Robert M. Mains, "The development of the strain-gage balance system for the supersonic wind tunnel at Lone Star Laboratory,"** *Bur. Ord. Bumblebee Ser. Rep.*, no. 51, Jan. 1947, pp. 1–61.

The material in this document was presented as a doctoral dissertation to the graduate faculty of Lehigh University in 1946. The paper first summarizes the general problem of measuring forces and moments in wind tunnels. This is followed by a brief review of the history of wind-tunnel balances. Then the procedure of selecting and designing a balance system for the Lone Star Laboratory is described. The objectives were (1) to measure at least lift, drag, and pitching moment; (2) automatic recording; (3) dynamic as well as static measurements; (4) an over-all accuracy of 1 per cent. A system was chosen whereby SR-4-type strain gages measured the forces and moments in the strut directly connected to the model.

Preliminary measurements were made in the Aberdeen wind tunnel to determine the specific problems which would be encountered. Experimental results were coupled with a theoretical study of diaphragm stresses. The following were the ranges of forces established: lift and yaw, 200 lb maximum; drag, 40 lb; pitching and yawing moment about the forward end of the balance strut, 1500 in-lb; no provision for rolling moment. There were twelve associated gage readings automatically recorded on a Brown electronic potentiometer. Temperature compensation was accomplished by small unstrained resistors in conjunction with the bridge gages. Experience gained with this balance showed the way to recommendations for improvement in future installations.

Frank L. Wattendorf, USA

Thermodynamics

(See also Revs. 85, 89, 122)

125. **V. Fischer, "The reflux condensation of vapor mixtures of an arbitrary number of components (Die Rückflusskondensation von Dampfgemischen aus beliebig vielen Bestandteilen),"** *Ann. Phys. Leipzig*, 1947, vol. 1, no. 4-5, pp. 139–152.

This paper supplements two previous ones to which reference must be made for some details [V. Fischer, *Ann. Phys. Leipzig*, 1940, vol. 37, p. 63, and 1943, vol. 42, p. 461]. The particular problem here treated is that of the condensation of a vapor of an arbitrary number of constituents when the vapor and condensate

flow in opposite directions, as in a rectifying column in which vapor flows upward and liquid flows downward. Equations are derived for calculating the concentrations of the constituents of both condensate and vapor. The method of calculation is applied by way of example to the process of separating liquid air into its constituents, and to the process of decomposing a mixture of methane, carbon monoxide, nitrogen, and hydrogen.

C. W. Smith, USA

Heat Transfer; Diffusion

(See also Revs. 88, 140)

126. Frederick Johnson, Robert Bentley, Robert Maurer, "Heat transfer in sphere beds," *U. S. atom. energy Comm. Doc.*, no. 990, May 19, 1947, pp. 1–16.

Experimental data for mass transfer from a bed of spherical pellets of benzoic acid to water is presented for a range of Reynolds modulus from 2000 to 3000. The extension of the results to heat transfer is suggested. Myron Tribus, USA

127. A. V. Lykov, "On the theory of heat waves," (in Russian), *Bull. Acad. Sci. USSR Ser. tech. Sci. (Izv. Akad. Nauk SSSR Ser. tekh. Nauk)*, July 1948, no. 7, pp. 1003–1008.

Classical one-dimensional problems in nonsteady heat diffusion are treated under the assumption that the temperature of the medium is subject to simple harmonic oscillations. Laplace transformation is used. The formulas derived involve series of elementary transcendentals and of Bessel functions of order zero.

I. Opatowski, USA

128. H. Brinkman, G. A. W. Rutgers, and J. C. de Vos, "Difficulties in the determination of the true temperature of tungsten" (Difficultés dans la détermination de la température vraie du tungstène)," *Rev. Opt. (théor. instrum.)*, July 1948, vol. 27, pp. 426–430.

Measurements of the intensity of radiation emitted from a rectangular filament of tungsten were made as a function of electric current at wave lengths of 6500 and 5600 A. The monochromatic temperature of brilliance was calculated relative to the melting point of gold. The true temperature was then calculated using the values of emissivity of Hanmaker. The two independent determinations yielded identical values up to 1800 K. From 1800 to 2800 K, the true temperature calculated from the brilliance temperature for 5600 A differed up to 25 K from that for 6500 A. The authors attribute the disagreement to erroneous values of emissivity. They summarize the available experimental data, point out discrepancies, and emphasize the effect on the metal's emissivity of impurities, surface structure, and adsorbed layers of gases. H. G. Elrod, Jr., USA

Theoretical and Experimental Methods

(See also Revs. 2, 3)

129. L. Fox, "A short account of relaxation methods," *Quart. J. Mech. appl. Math.*, Sept. 1948, vol. 1, pp. 253–280.

In this paper the author gives a general review of the present status of the numerical method of solving systems of equations by the relaxation technique. While the paper contains nothing new, it gives a very clear exposition of the origin of the idea and of its method of application to simultaneous equations arising either as a purely mathematical problem, or in connection with various physical problems. As illustrations, a vibration problem using relaxation and Rayleigh's principle is solved, and a simple Laplace equation is treated after first reducing it to a system of differential equations. The paper closes with a list of some of the types of problems that have so far been solved by relaxation methods, pointing out along the way what is now known of the limitations as well as the advantages of the method.

Howard W. Emmons, USA

130. Sir Richard Southwell, "Relaxation methods: An engineering approach to computation," *J. Instn. civ. Engrs.*, Oct. 1948, vol. 30, pp. 351–378, plus 2 charts.

This paper is the James Forrest Lecture of 1948. The author discusses the relaxation method from a philosophical point of view, and reviews the advances made in this method up to 1937, stressing at all times that concentration upon the errors of a desired quantity is a dominant characteristic. Simple numerical examples are presented and the results of a number of more complicated problems are shown graphically.

Henry J. Barten, USA

Acoustics

(See also Revs. 5, 8)

131. W. Roth, "Scattering of ultrasonic radiation in polycrystalline metals," *J. appl. Phys.*, Oct. 1948, vol. 19, pp. 901–910.

It would perhaps be sounder to consider this investigation as one of inhomogeneous interaction of polycrystalline metals with ultrasonic radiation, rather than one of scattering.

Within the admittedly questionable experimental accuracy of the data, the attenuation of ultrasonic radiation appears to vary as $1/\lambda$, contrary to earlier findings of Mason and McSkimen ["Attenuation and scattering in metals and glasses," *J. acoust. Soc. Amer.*, May 1947, vol. 19, p. 464]. The latter investigators insist on a $1/\lambda^4$ law in accord with the Rayleigh theory of scattering, in spite of the author's results. They propose that a different mechanism for absorption operates in the frequency range of this paper, calling it a diffusion process ["Energy losses of sound waves in metals due to scattering and diffusion," *J. appl. Phys.*, Oct. 1948, vol. 19, pp. 940–946]. In the reviewer's opinion the interaction of ultrasonic radiation with polycrystalline metals is much too complicated a phenomenon to be amenable to any simple treatment.

The author's figure of merit-predicted pulse-transmission criterion represents another version of the Mason-McSkimen expression $(c'_{11} - \langle c'_{11}\rangle_{av})/\langle c'_{11}\rangle_{av}$ used to indicate the degree of anisotropy of the individual crystals composing the aggregate polycrystalline metal. Such data should be of interest to those concerned with the application of ultrasonics for testing and inspecting materials. Louis Gold, USA

132. Louis Bauer, Paul Tamarkin, and R. B. Lindsay, "The scattering of ultrasonic waves in water by cylindrical obstacles," *J. acoust. Soc. Amer.*, Nov. 1948, vol. 20, pp. 858–868.

Experimental work done on the scattering of ultrasonic waves in water by cylindrical obstacles ($^1/_4$-in. steel rod, $^1/_2$-in. steel rod, and $^5/_8$-in. polystyrene tube) is described. The radii of the obstacles were much larger than the wave length of the radiation (wave length 1.3 mm, frequency 1145 kc).

A quartz-crystal source, an obstacle and an ADP microphone were placed in a tank. Pressure measurements were made in the tank, with the obstacle at different distances and angles from the source. The paper contains a large number of graphs presenting

the pressure distribution across the tank perpendicular to the axis of the beam, at various distances from the source. The general conclusion from these tests was that diffraction, rather than reflection and refraction, plays the predominant role in the scattering produced by such obstacles. Near the obstacle, the amplitude distribution showed a great deal of fine structure like that corresponding to Fresnel diffraction of light, while at the larger distances the fine structure degenerated into a smoother Fraunhofer pattern. Plotted also were the points of maximum pressure at each cross section. Lines connecting these points diverge from the axis; however, they do not always diverge from well-defined points. The radiation field did not have a plane wave front, but was characterized by a slightly curved wave front, making the theoretical approach very difficult. Robert Fehr, USA

133. **F. L. H. M. Stumpers, "On a nonlinear noise problem"** (in English), *Philips Res. Rep.*, Aug. 1947, vol. 2, pp. 241–259.

An analysis is presented of a problem in which noise from a normal source is passed through a filter with a rectangular amplitude-frequency characteristic. The output is applied to a vacuum tube with a nonlinear characteristic. The resulting energy spectrum is analyzed by correcting a method first presented by Franz. The spectrum is computed for a power characteristic and also for a polynomial characteristic for the vacuum tube. In the former case, the partial spectra around multiples of the original central frequency have different forms, distinguished by their order. The spectra of different order are independent, so that, even in the case of overlapping, the energy can be computed by simple addition. The noise spectrum for a special case involving the presence of one or two carrier waves is also calculated for a tube with a fourth-degree characteristic. Robert T. Beyer, USA

134. **Fritz Ingerslev and Walther Frobenius, "Some measurements of the end corrections and acoustic spectra of cylindrical open flue organ pipes"** (in English), *Trans. Dan. Acad. Tech. Sci.*, 1947, no. 1, pp. 7–44.

More accurate formulas are derived for the proper physical length of the cylindrical open flue pipe. A study was made of the effect of the scale, the height, the width of the mouth, the air consumption and nicks on the sound produced.

In one series the mouth width was constant; in the other its ratio to the diameter was constant. Harmonic analyses showed that the sound pressure was proportional to the width of the mouth. Reduction of the pipe diameter, increase of the width, reduction of the height of the mouth, and use of higher air pressures, all favored the generation of the higher overtones. The fundamental was favored, on the other hand, by the use of low air pressures and nicks. A. H. Fiske, Jr., USA

135. **J. W. Miles, "The coupling of a cylindrical tube to a half infinite space,"** *J. acoust. Soc. Amer.*, Sept. 1948, vol. 20, pp. 652–664.

The author treats the problem of a cylindrical tube coupled to a half infinite space by an aperture in an infinite plane. The general theory is applied to the computation of the radiation admittance of a circular aperture in a circular tube, and of both a symmetrical and asymmetrical slit-aperture coupling the infinite half space to an infinite slot. The basic wave equation for a set of orthogonal cylindrical co-ordinates is solved, and solutions which are valid in the tube and in the half space are obtained. Both solutions are chosen so as to match the impedance of the aperture which couples them.

A variational formulation of the aperture impedance is obtained which is such that the impedance value is stationary with respect to first-order variations of the normalized axial velocity distribution in the aperture. The variational solution for the conductance and susceptance of the radiation admittance is obtained in terms of a set of functions which satisfy the boundary conditions on the aperture. The range of validity of the correction developed by Rayleigh for the resonant wave length of an open-ended pipe is determined by comparison with the author's exact solution. In addition, the pressure field in the half space is computed.

Albert London, USA

136. **E. Gerjuoy, "Refraction of waves from a point source into a medium of higher velocity,"** *Phys. Rev.*, June 15, 1948, vol. 73, pp. 1442–1449.

The intensity of sound waves penetrating from a medium of low velocity into a medium of higher velocity depends upon the angle of incidence. Up to a certain critical angle, sound waves travel directly into the second medium and are spread out by refraction to reach all points in that medium. At incidence angles greater than the critical angle, however, the sound is essentially totally reflected, only a very small part of the incident energy penetrating through the boundary. The author presents a mathematical analysis of these two ways by which sound can reach points in a second medium and he compares their intensity. He points out that the component entering at greater than the critical angle decays exponentially. This component, nevertheless, has an intensity greater than that entering at less than the critical angle at points in the second medium near the interface, but distant from the source. This fact permits a simple experimental test of the theory. R. W. Samsel, USA

137. **Uno Ingård, "On the radiation of sound into a circular tube, with an application to resonators,"** *J. acoust. Soc. Amer.*, Sept. 1948, vol. 20, pp. 665–682.

The radiation of sound into a circular tube, taking into account the effect of higher-order modes, is considered in great detail by the author. The steady-state solution of the wave equation for a source of circular symmetry located at one end of the tube is shown to consist of an infinite number of wave types, some of which are transmitted and some of which are attenuated. The case of a plane piston having a radius less than or equal to the radius of the tube is treated in detail. Pressure distribution in the tube and the radiation impedance of the piston, together with equivalent circuits, are calculated. Tubes of infinite length and finite tubes terminated by a rigid wall, or having an axial impedance, are considered.

All calculations are illustrated by numerous charts in which two important parameters are r_0/R, where r_0 is the radius of the piston and R the radius of the tube, and R/λ, where λ is the wave length of the wave in question. Some experimental measurements are described which agree well with theory. The resonance frequencies of cylindrical resonators are computed. Slight corrections of the classical theory of resonators are required to obtain agreement with experiment. This paper will be of interest to those using tubes or cavities for measuring acoustic impedance, microphone responses, etc. Albert London, USA

138. **Antonio Gigli, "Sound absorption and transmission measurements,"** *J. acoust. Soc. Amer.*, Nov. 1948, vol. 20, pp. 839–845.

This paper is a discussion of the equipment and type of measurement performed in the architectural acoustic division of the Instituto Elettrotecnico Nazionale of Turin, Italy. Separate undamped rooms are used having volumes of the order of 300

cubic meters and total wall areas of 267 square meters. The properties of absorbing materials are measured by observing the change in reverberation time caused by inserting 10 square meters of material on one wall. The sound-absorption coefficient is calculated from the change in reverberation time by means of Eyring's formula. A number of measured curves for materials are given.

By using two chambers the transmission loss for various types of partitions can be measured. Results comparable with those of Meyer and the National Physical Laboratory have been obtained. The absorption introduced by people in a reverberant room has been measured. Finally, experiments have been made on the effect of walls constructed from Helmholtz resonators. Some discrepancy is found between experimental and theoretical resistance coefficients for such resonators.

Warren P. Mason, USA

Ballistics, Detonics (Explosions)

(See Revs. 41, 149)

Soil Mechanics, Seepage

(See also Revs. 40, 63)

139. Adalbert Pogany, "The bearing capacity of piles," *Civ. Engng. Lond.*, Nov. 1948, vol. 43, pp. 569–572.

This is a report of an investigation conducted in Poland primarily to determine the validity of theories proposed by Dörr (1922) as opposed to those of Terzaghi (1925). The former contended that axial and frictional resistances were most important and denied the influence of lateral shearing forces caused by soil compression during driving. On the other hand, Terzaghi considered the envelope of stresses of primary importance.

The author determined the penetration of short pointed piles 15 cm in diameter when pushed into various types of soil. Similar tests were made using fresh mortar instead of soil. At a certain penetration, the piles were extracted before the mortar was completely hardened. Examination of cut sections revealed the presence of a cylinder of moving mortar, the shape of which was independent of the type of pile point. While the type of point influenced the first phase of movement, it was later outweighed by other factors.

The author's conclusions, favoring Terzaghi's theory, are: (1) The shape of the point has little influence on bearing capacity. [His load-penetration curves do not appear to substantiate this fully for all soils tested.] (2) The range and degree of compaction near the pile is small. (3) Shearing stresses arising in the soil around the pile during driving influence the bearing capacity most.

Harry A. Williams, USA

140. N. Nanninga, G. A. Oosterholt, E. C. W. A. Geuze, and A. W. Koppejan, Editors, "Proceedings of the Second International Conference on Soil Mechanics and Foundation Engineering" (in English), Int. Conf. Soil Mech. Found. Engng., Oostplantsoen 25, Delft, 1948. Paperboard, 8.5 × 11.2 in., 6 vols., 75 guilders (approx. $28.40).

This work represents a comprehensive accumulation of much of the research work done, throughout the twenty-two countries represented, since the first international congress in 1936.

The first five volumes of the Proceedings contain 361 articles on 45 different subjects (1642 pp. and approx. 1750 figs). A considerable quantity of field data gathered from observations on unusual construction projects throughout the world is contained in some thirty articles. Many new methods in laboratory and field testing techniques are presented, as well as some forty theoretical papers on earth pressures and stresses. The results of a number of investigations on the measurement of pore pressures are given in connection with stability analyses of earth dams and levees. Cases of slide failures are cited and analyzed. The section on soil stabilization contains thirty-seven papers covering physical, physicochemical and mechanical methods of stabilization, with applications to highway and airport subgrades.

Articles on the special topics of vibrations in soils, aerial photographing for determining soil characteristics over large areas, thermal conductivity of soils and permafrost investigations are also included, as well as many papers on miscellaneous subjects.

The sixth volume of the Proceedings has not yet been received in this country. It contains the discussions of the papers delivered, and descriptions of soil-mechanics laboratories in fourteen countries.

The table of contents of an additional seventh volume has been announced, but its publication is contingent on at least one thousand advance subscriptions.

Because German engineers were unable to participate in the conference it was decided to publish an additional eighth volume dealing exclusively with German activities in soil mechanics since 1939. This volume (215 pages) is entitled *Abhandlungen über Bodenmechanik und Grundbau, 1939–48* and contains a review of German soil-mechanics work, thirty-one individual papers and a classified bibliography.

Eben Vey, USA

EDITOR'S NOTE: Important individual articles in these Proceedings are being reviewed separately in the usual manner and it is hoped to publish reviews of all selected papers within the next year.

Orders for volumes I through VI (75 guilders) and subscriptions for volume VII (15 guilders) should be accompanied by remittances in the form of bank drafts payable to the treasurer of the conference, c/o Amsterdamsche Bank, Delft, The Netherlands.

Volume VIII ($6.50) may be obtained from The Library, Graduate School of Engineering, Harvard University, Cambridge 38, Mass., USA.

141. V. A. Florin, "Some simple nonlinear problems on consolidation of a water-saturated earth medium" (in Russian), *Bull. Acad. Sci. USSR Ser. tech. Sci. (Izv. Akad. Nauk SSSR Ser. tekh. Nauk)*, Sept. 1948, no. 9, pp. 1389–1402.

A general solution is given by the author for the three-dimensional problem of consolidation of a two-phase system. It is shown that the conventional equations for one-dimensional consolidation represent a special case of the general solution which is presented.

Examples are given of special applications of the general solution, for instance to the case of a one-dimensional problem when the permeability coefficient varies with time as a function of the stresses and of the porosity of the soil skeleton. The statement is made that the same approach can be applied to problems when boundary conditions vary with time.

The method of finite differences is recommended for the solution of practical problems, and its application to a specific case is illustrated by an example. Finally, a solution is given for the case when the external load varies with time.

Gregory P. Tschebotarioff, USA

142. K. Hruban, "The influence of the heterogeneity of the soil mass on its deformation" (in English), *Proc. int. Conf. Soil Mech. Found. Engng.*, June 1948, vol. 1, pp. 123–126.

Since the modulus of elasticity of sands has been proven by numerous experiments to be a function of the confining pressures, it is assumed in this paper to be equal to the product of a constant by a certain power n of the depth. The author also links it to the reciprocal of the Poisson ratio.

By setting up the equations for the settlement under a circular plate, it is shown that in order to satisfy the condition that the settlement can never be infinitely large, the power n must be

smaller than unity. Moreover a value of zero would give a deflection increasing in direct proportion to the radius of the circular plate. A value of n between zero and unity, giving a Poisson ratio between one third and one half, is therefore assumed to be correct, and is used in a study of the stresses and deformations due to a vertical line-load, inclined forces, strip loading of a certain width, and a load distributed uniformly over a circular area. It is shown that the stress distribution and the deformations may be calculated readily with the help of Gamma functions.

As long as there are no discontinuities in the soil mass, these equations seem applicable to most settlement problems in sands.

Robert Quintal, Canada

143. K. E. Clare, "Laboratory studies relating to the clay fraction of cohesive soils" (in English), *Proc. int. Conf. Soil Mech. Found. Engng.*, June 1948, vol. 1, pp. 151–158.

This paper outlines the effect of the clay fraction on such engineering properties of cohesive soils as the strength, compactibility and permeability, and refers to the physicochemical properties of individual clay particles which are important in this connection. Experimental results and data obtained at the Road Research Laboratory relating to the properties of the clay fraction are presented.

Electron micrographs of various types of clay particles are shown.

Rollie G. Fehrman, USA

144. R. Haefeli, "On the compressibility of preconsolidated soil-layers" (in English), *Proc. int. Conf. Soil Mech. Found. Engng.*, June 1948, vol. 1, pp. 42–50.

This paper cites experimental data regarding: (*a*) the effect of the magnitude of the preconsolidation load on the compressibility of a loose sediment of soil slowly relieved to a given pressure; (*b*) the effect of the amount of relieving on the compressibility of such a sediment at a given preconsolidation load.

The conclusions drawn are that the coefficient of compression, with a constant amount of relieving, is independent of the magnitude of the preconsolidation load. On the other hand, at constant preconsolidation load, the compressibility increases with increased amounts of relieving. The increase in the compressibility of soils due to the release of pressure (and other disturbances) during the sampling process is therefore reaffirmed by the author. To mitigate these effects, it is proposed that consolidation tests be made in the field at the bottom of bore holes. A photograph of an apparatus designed to perform these tests is included. At the present time, it is recommended that the field tests be checked against the results obtained from standard laboratory tests.

Gerald A. Leonards, USA

Geophysics, Meteorology, Oceanography

145. H. J. Stewart, "A theory of the effect of obstacles on the waves in the westerlies," *J. Met.*, Oct. 1948, vol. 5, pp. 236–238.

The author presents a simplified theory of horizontal wave disturbances paralleling Rossby's theory of steady-state forced oscillations in the westerlies. The general differential equation of disturbances is transformed to polar co-ordinates and solved by Bessel functions. It is shown that Rossby's waves are a special case of this more general solution.

As a special case, the flow past a cylindrical obstacle is analyzed and a singly infinite family of solutions is obtained. These indicate that: (1) in the immediate neighborhood of an obstacle the disturbance wave lengths may differ considerably from the free-oscillation wave lengths; (2) within the limitations of the theory the disturbance patterns are not unique; and (3) oscillations which have amplitudes not determined by boundary conditions may exist and are thus of the nature of free oscillations.

The author states that, while the first conclusion was anticipated, the second and third conclusions were quite unexpected, and their significance is not apparent at the present time. If they are real phenomena, not introduced by the simplifying assumptions of the analysis, their role in the theory of weather forecasting must be expected to be very important.

Karl E. Schoenherr, USA

146. B. Neis, "A vortex model of the atmospheric turbulence (Ein Wirbelmodell der atmosphärischen Turbulenz)," *Z. Met.*, Jan.-Feb., 1947, vol. 1, pp. 114–122.

Following papers of Robitzsch (1919), Rümelin (1913), and Barkow (1915) the author develops a model of atmospheric wind structure. By superposing fields of cylindrical vortex sheets he explains records of gustiness. Additional investigation of energies shows the ratio of the kinetic energy of the turbulent flow, to that of laminar flow of the same average speed, to be 1.33.

Horst Merbt, Germany

147. F. Möller, "On the theory of the Moazagotl cloud (Zur Theorie der Moazagotl-Wolke)," *Z. Met.*, Aug.-Sept., 1947, vol. 1, pp. 321–324.

The problem of Moazagotl, or Chinook-arch, clouds has recently received considerable attention in meteorology. An explanation for them in terms of standing internal waves produced by the mountain barrier was introduced in a theoretical paper by P. Queney [*Dept. Met. Univ. Chicago Misc. Rep.*, no. 23, 1947], and subsequently discussed in terms of observations in the Rocky Mountain region by S. Hess and H. Wagner [*J. Met.*, Jan. 1948, vol. 5, pp. 1–19]. The present paper, on the other hand, provides a prediction, at least qualitatively plausible, of the position of these clouds in terms of temperature difference between the lee and windward side of the mountains, and the consequent variation of the geostrophic wind height. The resulting distribution of convergence and divergence is shown to cause the deformation of the streamlines to be displaced downwind if temperatures are lower to leeward, and vice versa.

The available data are still too sparse to determine which theory better predicts observations. The data of Hess and Wagner show the nodal surfaces expected from the internal-wave theory but not from the present theory, which is harder to investigate observationally due to the smallness of the temperature difference required. Nevertheless, the data presented by the author are sufficient to indicate the likelihood that Moazagotl clouds can be formed by more than one process.

Joanne Starr Malkus, USA

148. T. V. Davies, "Rotatory flow on the surface of the earth—Part I. Cyclostrophic motion," *Phil. Mag.*, June 1948, vol. 39, pp. 482–491.

The author considers the perturbations of a circular vortex in cyclostrophic motion. The density is assumed to be proportional to the pressure. By elimination of the velocity components and of the density, a differential equation for the pressure alone is obtained which, together with the boundary condition that the vertical velocity vanishes at the ground, permits a solution of the problem. A formal solution is given for the case that undisturbed velocity increases linearly with the distance from the center. This solution shows that the vortex is subjected to a southerly force which will give it a translational motion.

Courtesy of Mathematical Reviews B. Haurwitz, USA

149. L. W. Fraser and E. H. Siegler, "High-altitude research using the V-2 rocket," *Bur. Ord. Bumblebee Ser. Rep.*, no. 81, July 1948, pp. 1–90.

At the beginning of 1946 the Applied Physics Laboratory of Johns Hopkins University contracted with the Ordnance Department of the United States Army "to perform basic scientific work and instrumentation in the study of the physics of the upper atmosphere," making use of the war-head space in captured German V-2 rockets which were to be fired by the army for the primary purpose of military appraisal. This report is the first of a series in which the work will be described and the results given.

The first half of the report contains data on the characteristics and performance of V-2 rockets and describes the various instrumental and recovery techniques used. A summary is given of the results—mainly provisional—obtained so far, under the following headings: cosmic rays, solar spectra, and photography of the earth from high altitudes. M. V. Wilkes, England

Lubrication; Bearings; Wear

150. Jacques Huetz, "Contribution to the study of oil wedges (Contribution à l'étude du coin d'huile)," *C. R. Acad. Sci. Paris*, Nov. 8, 1948, vol. 227, pp. 956–958.

In order to test the Reynolds equation for hydrodynamic lubrication the author has measured the pressure distribution in a specially designed test bearing having an exaggerated diametral clearance. It has a mean radius of 2.6 cm, a clearance ratio of one part in 17 and a length-to-diameter ratio of about 1.9. The eccentricity ratio is held fixed at 0.72 by means of collars integral with the outer cylinder which locate the inner cylinder to within ±0.01 mm, and also seal the ends of the bearing.

In the vicinity of the point of minimum film thickness the measured pressure was found to agree well with the theory but at positions 90 deg away it was found to disagree by as much as 40 per cent. It is suggested that, in spite of the low Reynolds number for the system under the speeds and viscosities used, this discrepancy may be due to discontinuity of fluid velocity and to permanent vortices. John T. Burwell, Jr., USA

Marine Engineering Problems

(See also Revs. 6, 101, 104)

151. Roland E. Olson and Norman S. Land, "Effect of afterbody length and keel angle on minimum depth of step for landing stability and on take-off stability of a flying boat," *Nat. adv. Comm. Aero. tech. Note*, no. 1571, Sept. 1948, pp. 1–27.

Tests were made to fill partially the need for information on the effect of afterbody dimensions on the hydrodynamic stability of a flying boat in smooth water. The dimensions investigated were depth of step, angle of afterbody keel, and length of afterbody. An analysis of the data showed that, as either the afterbody length or keel angle was increased, an accompanying increase in depth of step was required in order to maintain adequate landing stability.

A comparison of models having differing afterbody lengths, but each having a depth of step which provided adequate landing stability, revealed that there was no marked change in the take-off stability. A similar comparison for models with differing keel angle showed that increases in keel angle resulted in a large increase in the angle of stable trim for take-off, and some increase in the range of stable center-of-gravity location for take-off.

A large change in gross load had little effect on the landing stability. The landing-test results have been reduced to an empirical formula which gives the minimum depth of step in terms of afterbody length and keel angle. This formula is compared with results from other tank tests, and the correlation is fairly good. The formula thus becomes of use in preliminary design.

Ernest G. Stout, USA

Biomechanics

(See Rev. 2)